INCREASING PRODUCTION DECREASING COSTS

BY

C. U. CARPENTER

MEMBER, AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AUTHOR, "PROFIT-MAKING MANAGEMENT"

NEW YORK
THE ENGINEERING MAGAZINE COMPANY
1920

PRESS OF
BRAUNWORTH & CO.
BOOK MANUFACTURERS
BROOKLYN, N. Y.

PREFACE

YEARS of actual shop practice, a close, continuous observation of the improvements in methods of production, a study of the gradual evolution of the various essential elements of *modern production practice,* these have revealed the gradual growth of a real science of production which ultimately will prove to be as accurate and as well founded as the science of engineering. When it reaches that state it will be of inestimable value to American manufacturers. Each one of these elements of modern production practice forms a problem in itself. The fundamental principles covering each are exact and definitive in character, and are general and universal in their applications. Methods and systems used in various industries and in different factories may and do vary widely, but these general principles will always stand immovable and unchangeable as the basis of the science of production. A shop is efficient or inefficient just as it adheres to or neglects these fundamentals.

The evolution of these principles is the result of the constant, painstaking work of many eminent production engineers. When The American manufacturer awakens to the value of this work he will acknowledge the great debt that we all owe to such pioneers and leaders in industry as Taylor, Gantt, Emerson, Barth, Knoeppel, Church and others.

The author gladly acknowledges his personal debt to his colaborers in the great field of industry, for each of them has achieved results that are of great value and are real contributions to production engineering.

From such a background of study and experience this book has been written, with the belief that matters of production in the past have been too often presented as complex and complicated. The natural result has been that many manufacturers after reading the papers and articles on such subjects have a feeling that the introduction of the methods outlined would involve too great a disruption of their own practice, and too little confidence is inspired in the newer methods to make the reader feel certain that should he attempt to apply them he will achieve reasonable success.

The particular methods presented in this book have been de-

veloped and have proven successful in actual use in a large number of plants which the author has organized: One includes a company with as few as 150 employees, two others with approximately 260 employees each, and another has over 8,000 workers. This experience indicates the flexibility of the methods offered.

While the presentation is based on fundamental principles, of which five are recognized, all refer to matters which are solely concerned with the question of increasing production and at the same time reducing costs. So the question of factory production is approached from an intensified practical standpoint and subjects are so arranged as to make it possible for the reader to follow the book chapter by chapter and introduce the methods advocated if he is so disposed.

After declaring and explaining the fundamental principles methods are offered for making a standard survey of each department of a manufacturing plant. This investigation should bring a knowledge of what the plant is actually producing and what the products are actually costing. Following chapters take up the question of establishing standard hourly outputs for both machines and operators through the making of proper studies. Then follows methods of applying the standard hourly outputs without arousing the antagonism of the worker, but rather in a manner to secure his coöperation.

The important subject of stock routing and tracing is then discussed followed by the development of progressive machining and progressive assembling.

Then, in order, are taken up the advantages of a survey of possible productive capacity of the plant, the delicate question of wage systems and their effect upon labor, the matter of controlling stores to prevent overstocking of materials and supplies, the functions of the purchasing department, the important matter of tool design, emphasizing that the tool-design department must work in conjunction with the production department, methods for tracing tools through the shop and the all important subject of costs.

The final discussion turns to the absorbing question of organization with emphasis upon the system of committees which the author has developed and used successfully.

Throughout this entire presentation an earnest effort has been made to have this volume as practical as possible, in order that it will prove of major usefulness to American manufacturers.

Dayton, O. C. U. CARPENTER.

July, 1920.

TABLE OF CONTENTS

OPENING STATEMENT

PAGE

WE HAVE SOME THINGS TO THINK OF BESIDES PROFIT................ 2

Is the condition of American factories efficient?—The question in the manufacturer's mind—The answer—We have learned much in three years—Big difficulties caused by little ones—The problems of factory management—(*A*) Determination of standard hourly outputs—(*B*) Finding out what is being actually produced—(*C*) Locating the troubles and overcoming them—(*D*) Control of flow of parts through the shop—(*E*) No overbuying nor underbuying—(*F*) The handling of labor—(*G*) Developing the organization—Your own organization must do this work—Give them a chance.

CHAPTER I

REDUCING COSTS—INCREASING PRODUCTION—DEVELOPING EARNING POWER.. 6

How did you run your small shop—No one had to tell him—The same principles apply to the big shop and the small one—When the "Old man" bossed the job—The first principle of production—The second principle of production—The third principle of production—The fourth principle of production—The fifth principle of production—The boss controls the shop—The same principles apply to the big or little shop alike—That personal touch—They will bring home the profits—Getting the organization back of this—Bring together experience, ability and knowledge—Suggested method of procedure—Use of committees—Committee No. 1 on production reports—Committee No. 2 on standards of production—Committee No. 3 on purchasing and stores—Committee No. 4 on stock routing and tracing and trucking—Committee No. 5 on production methods and shop arrangement—Committee No. 6 on standard design, tooling, tool design and machine tools—The library—The use of surveys—The average shop conditions—Modern production methods are simply applied common sense—The five principles of modern management—Actual examples—Production reports—How we quickly reduced costs and increased production—Conditions of stores department, etc.—Introduction of methods—Another example—Get the support of your organization and proceed then to introduce these modern production methods—Fit the system to the factory conditions—Don't try to fit the factory to the system—The support of the organization must be gained—The foremen—What are foremen doing—Methods that will help the foremen.

CHAPTER II

PAGE

THE "COLD FACT" SURVEY 34

Let us deal with cold facts—Inspection of departments—Quick and positive action—The questions—Surveys—Don't delegate to subordinate—Plan of operation—The production survey—Production survey—Organization—Systems—Labor—Labor Efficiency, promotion, discharge, Turn over—Stock tracing—Tooling—Scrap—Small tools—Lubrication—Machine tools—Materials—Costs—Assembling—Delays on deliveries—Production—Inspection—Sales department complaints—Cover all phases—Replies invaluable—Discloses where to start to conquer inefficiency—The foreman survey—Foreman's survey—Labor—Tooling—Lubrication—Stock tracing and stores—Supplying work to workers—Work of a stock tracing department—The stock tracing survey—Starting materials—Routing—Authority—Finished parts stores and assembling room delays—Suggestions—Stores survey—The stores survey—Order limits—Rush list—Requisitions—Bin cards—Abandoned stock—Scrap—Receiving department—Survey of purchasing department—Quotation survey—Purchase orders—Requisitions—Rush items—Follow up system—Quotations—Specifications—Dead materials—Filing system—Survey of cost department—Cost survey—Cost products—Use of cost records to locate high costs—Forms—Is present system safe?—Wage systems—Scrap—Labor costs—Suggestions—Overhead—Special reports—Survey on inspection—Inspection survey—Survey of management—Management survey—Training—Co-operation—Detecting the efficient and inefficient—Instruction in policies—Wage rates—Employment—Costs—Stores—Stock tracing—Purchasing.

CHAPTER III

LEARNING ACTUAL PRODUCTION—LOCATING POINTS CAUSING TROUBLE—CONSIDERATION OF PRINCIPLE NUMBER ONE 71

Importance of accurate production reports—Production reports supply the lost links in the chain—Production reports as locaters of trouble—Big difficulties caused by little ones—Avoid too much detail—The true function of reports—Promptness—Build upon your present conditions—The best plan—Choosing the man to head this work—The function of these production reports—Production reports—From the simple workmen's time tickets flow all production and cost data—The time tickets must be extended for payroll—The payroll—The individual efficiency records—Production reports—Group them according to part and operation—Simply add together the important items—We at once have the production reports—Locating the inefficient spots—Any shortage will show up—An example—Stock tracing records—The collection of cost data and its relation to production reports—Avoid too much detail—The operator's job and time ticket—This ticket the foundation of system—The first steps in the system—The keystone of the arch of production—The real function of this column—The substitute function—The difference—The important question of scrap—Number of parts on hand—Stock tracing—Comparative data—Use to make of this highly important report—You immediately locate your weak spots—The superintendent has control—It is not always the production department's fault—How the superintendent handles the reports—Whatever the fault, it is remedied—Effect on the foremen—An actual example—Principle

PAGE

number one—Foremen's production reports—Production reports as stock tracing sheets—Operation as stock tracing sheet—First step—Second step—Third step—Fourth step—The superintendent's job—Assembly production reports—Method of assembling—Discussion of report—Bring out the facts—Special trouble men—Final assemblage reports—Discussion of report—Factory Manager's report—Discussion of report—The job boss and his report—He is important—How to develop him—The job boss's production report—Individual operators' reports—He finds that the manager knows—Engineering department—Raw material requirements—The blanket requisition—Production reports on special contracts—Combined reports—stock routing—Tracing costs—Raw materials stores for special contracts—Simplifying the official O. K.—The treasurer checks all purchase orders against the blanket requisition—The "follow up" date—Delivery of work to the factory—The delivery schedule—Location of stoppages—Combining this work with costs—The main production committee—The program—Failure to act quickly is inexcusable—Trace pending matters—The condensed report—The subsidiary committees—Opposition to be expected—Blackboards—The Factory Systems department—This department gives control.

CHAPTER IV

CONTROLLING THE FLOW OF PARTS THROUGH THE FACTORY—LOCATING ALL DELAYS AND DIFFICULTIES—OVERCOMING THEM.......... 119

Stock routing and tracing—What the stock routing and tracing department controls—Discussion of "A"—Discussion of "B"—Discussion of "C"—Discussion of "D"—Discussion of "E"—Discussion of "F"—The production schedule—The simplest plan—Deliver materials at regular intervals—Delivery of materials according to schedule—Material piles up if the foreman does not use it—Hunting the trouble—This will disclose causes of troubles—Stock routing and tracing—Finished parts stores—Bin cards—Keeping bin cards "up to the minute"—Consideration of "work" and "rush limits"—The rush limit—The authority of the stock tracing department—Examination of cards—How to locate the parts in the shop that are nearest the finished stores—Notifying the foreman—The foreman must report anything that is holding him back—Locating the real source of trouble—Stop the recurring shortages on the same parts—Stock tracers' monthly written report on delays and causes—Report deserves attention—The solution of the problem of eliminating shop troubles—The reduction of working capital tied up in dead or slow-moving materials—Reduction of scrappage from changes—Slow-moving materials in stores—Slow-moving parts in process of manufacturing—Too much tied up in finished stores—The way to correct this—Determining the amount that should be in process of manufacture and in finished stores—Balancing up parts—The committee—Stock tracing in the assembling department—Schedules of necessary production—Study of parts—Classify parts in two sections—Section dealing with simple operations—Section dealing with difficult operations.—The very first step—The survey—Handling of parts through the shop—Departmental stock platforms—Visual evidence of stock conditions—Machinery and output survey—Serious delays often caused by continual shortage of only a few parts—Machinery and output record—Survey of tools and fixtures—Arrangement of machinery.

CHAPTER V

PAGE

DETERMINATION OF STANDARDS 149

The dissatisfied worker—The dissatisfied employer—The outcry against the workman—The outcry against the employer—The unwritten law of the worker—What the workmen fear—From actual experience—The workman knows the art of camouflage—Fear of exploitation—How the condition has arisen—Is there a remedy for the situation—Conclusion—The big principle.

CHAPTER VI

PRINCIPLE NUMBER TWO: THE KNOWLEDGE OF WHAT SHOULD BE PRODUCED BY WORKMEN AND MACHINE TOOLS AND WHAT SHOULD BE DONE BY EACH AND EVERY DEPARTMENT 156

Discussion of these four divisions—The hostility of the shop—The production of the plant depends upon getting the full production out of each machine—The way to do it—"Committees"—Theory versus practice—The classification of parts—An example—Lack of time—Greater accuracy—The three main divisions of work.

CHAPTER VII

DETERMINATION OF STANDARDS OF HOURLY OUTPUT ON JOBS REQUIRING A LONG MACHINING TIME—REMOVAL OF METAL 166

Standards—Hit or miss methods must go—The attitude of the organization—Thousands of experiments—Tables of best cutting speeds, feeds, depth of cut—Simple after it is once started—The tool when removing metal does not cut it off—It tears it off—How the tool tears away the chip—Cutting cast iron—Quality of high speed tool steel—Shape to which tool should be forged—Shape should allow of as many regrindings as possible—The 4th shape best—Heat treatment (hardening) of tools—The usual method—With bad results—Stick to your standards—First step—Conclusion—Possible standards—Usual practice—Use of the automatic grinder—The standard rules for grinding tools (for roughing cuts)—Cutting edge—The curved cutting edge—Straight edge causes chatter—Curve should be as large as possible—Effect of slow speed—Shallow cuts on cast iron—Conclusions—Study your conditions—Lip and clearance angles.—Removal of steel—The effect of blunt vs. acute cutting angles—The general law of determining cutting angles—Proper clearance and lip angles—Clearance angles—Conclusion—Steel and cast iron—F. Dempster Smith—Steel and cast iron—Dr. Nicolson—Soft steel—Mr. Taylor—Steel and cast iron of average quality—This angle better than angle generally used—The steel—Chilled iron—Cast iron—Side and back slope—Advantage of steel side slopes—Back slope—Lubrication—Water in large volume—Great gains possible—Conclusions—After we started to use these tables we soon got results—Using these tables—The opposition is human nature—Tact or diplomacy—The man to do the testing—The necessity for a high-grade man—The usual error—The chief fault with most attempts—Select your best man—The inexperienced man will not do—The committee—Reports—How to make speed—The standards to be settled—The place to do the testing—Nature of the tests—The test for "handling

PAGE

and set up" time—The division of the total time required for a piece of work—I do not divide my elements as finely as others—Determining quickly this time on new jobs—Forms—Simplify your forms—The tables of cutting speeds, feeds and depth of cuts—Practical table of cutting speeds—Steel—Roughing cuts, standard $1\frac{1}{4}$-inch tool, 1-inch tool, $\frac{7}{8}$-inch tool, $\frac{3}{4}$-inch tool, $\frac{5}{8}$-inch tool, $\frac{1}{2}$-inch tool—Practical table of cutting speeds—Cast iron, roughing cuts, standard $1\frac{1}{4}$-inch tool, 1-inch tool, $\frac{7}{8}$-inch tool, $\frac{3}{4}$-inch tool, $\frac{5}{8}$-inch tool, $\frac{1}{2}$-inch tool—The determination of the shortest time in which a piece of work can be done using the data given in these tables—Chart for finding time required to remove metal when using cutting speed, feed, depth of cut as per tables—The Poliakoff shop rule—Use of the tables—The standard recurring work vs. non-repetition work—How to get the data into the shop and in use—Tables for cutting speeds, feeds and depth of cuts on other metals—Using this table as a guide then make some check tests—Data on finishing cuts—Lathe—Difference in performance between high speed and carbon steel tools—Carbon steel tools.

CHAPTER VIII

MILLING MACHINES 222

Increasing production—Reducing costs—What determines your output—your direct costs—your factory overhead costs—Types of mill—The action of cutting metal—Heavy arbors—Commercial cutters—The cutters—Angle of rake—Clearance angle—Use cutter grinders—Heat treatment and hardening—Lubrication or cooling—Results of tests—Tests made by Cincinnati Milling Machine Company flooding work.—Compare with your results—Compare these with your own results—Lubrication of cast iron—Great increases in production with present milling machines possible—General facts—How long should cutter last until regrinding is necessary—An example—The general rule—These exceptions—Finishing cuts—Cast iron—Spiral mills—Roughing cuts—Cast iron—$\frac{1}{8}$-inch, $\frac{3}{16}$-inch deep using shell end mills—Roughing and finishing cast iron—Spiral milling on machinery steel—Keywaying on machinery steel—Steam lubrication—Strength and design of fixture—Strength of machine tool—Method of lubrication—The man—The place—The classification—Lubrication or cooling—The study of handling time and set-up time—The average workman's loss of time—The handling time—What the workers are doing—The importance of milling machine design and its effect upon industry.

CHAPTER IX

THE PLANER DEPARTMENT 245

Importance of planer department—The two divisions of planer work—First classification the more important—Accounts for delays—Provides chance for savings—Handling time-Leveling-Clamping-fixtures—Savings in time—Put standard date on blue-prints—Fixtures for planers—Gages—Cutting speeds and feeds—Feeds—Table of cutting speeds—The determination of the shortest space of time in which a planer job should be done called "The standard time" for that job—The elements making up total time of a job—The cost of this—The analysis of these elements—Removal of metal—Stoppage of planer to replace dulled

PAGE

tools—Loosening and removing clamps and stops—Removal of work from planer bed—Return speed—Old machines—Modern practice—Multiple tools—Special devices—Study of casting and forgings—Training of workmen.

CHAPTER X

THE DETERMINATION OF STANDARD HOURLY OUTPUTS, ON JOBS REQUIRING A SHORT MACHINING TIME............................ 257

Usually neglected yet most important—The small saving—The basic principle underlying the plan—Savings come from elements other than machining time—The three main elements to study—The study—The committee—Classification—Discussion of these ten elements and action to take—Action to take—Saving handling time—Can the worker keep up the pace—Don't wait for improvement—Follow up the improvements—Selecting the job—The providing of the operator at all times with ample supplies of both tools and parts—Study of jigs, fixtures, etc.—How to quicken up a slow job—Study of the set-up—The actual set-up—Special men for set-up—The establishing of set-up time, making the test—The place to make tests

CHAPTER XI

DETERMINATION OF STANDARD HOURLY OUTPUT FOR BENCH WORK AND ASSEMBLY... 271

Materials, inspection, supplies—The workmen must produce work within tolerances—Shortages of parts and small tools—Location of parts—Arrangement of machine tools needed—An example—The actual procedure of determining standard hourly output in assembling—Problem is simplified—Is this too "red tapey"—The value of this analysis—The start—Setting the standards—The difficult jobs—Using the skilled worker—The final results—The possible sub-division—The instruction card—Adaptation to heavy work—Methods of assembling—Assembling of special contracts.

CHAPTER XII

INSPECTION... 28

Its common-sense object—How inspection saves money—Assembling department inspection—Final inspection—The authority of the chief inspector—Inspection of raw materials—Inspection of work in process—Determining the percentage of inspection—O. K.'ing of time tickets and scrap records—Gages.

CHAPTER XIII

THE "PROGRESSIVE METHOD" OF MANUFACTURING.................... 286

Don't rip up the old methods too soon—Select the main parts—Group the minor parts—Develop regular schedules—Some examples—The proper method of undertaking this work—The advantage—Flow of parts perfect—No excuses allowed—Reduction of parts in process—

PAGE

No delays in assembling room—Stock tracing—Eliminates systems needed—The assembling department—The results—The usual method—My method—An example—The group bonus—How to plan this method—Method of conveying parts from one operator to another.—The final result.

CHAPTER XIV

THE PURCHASING DEPARTMENT 300

This department can either make or break you—Tieing up of working capital—Overbuying, underbuying, accumulations, shortages must be stopped—What the purchasing agents' methods must cover—Material list—Combined material list—Specifications—Market survey—Quotation records—Order records—Follow up—Filing system—Checking prices—Pushing improvements—Co-operate with stores—Sales department co-operation—Reports to general manager—System of testing—Caution; do not go too far—Blue prints—No changes allowed—Splitting up your buying—How to get the list—Getting quotations, how to proceed—Possible substitution of standards—Handling of quotations—The danger signal—The placing of orders—The requisition—Factory bank—Stores department often a "mess"—Results—Purchasing department and stores must be made to co-operate—Keep their records together—Delays in getting requisitions through—The way to "turn the trick"—The big requisition—The committee—The follow up—Handling new discoveries—Difficulty in getting reports from the shop—How to get their co-operation—The National Manufacturing Company—No small matter—The filing system—The part that the management ought to take in the purchasing department operations.

CHAPTER XV

STORES DEPARTMENT 319

The factory bank—Watch as carefully as your bank account—12 per cent. of total capital tied in useless material—Stores underbought—The functions of a stores department—Anticipate your trouble—The chronic shortage—A general factory condition—The machining department—Eating up working capital—How to control these factors—When to "Order fresh supplies"—The amount to order at one time—Tendency to order too much—When just enough is ordered—Determining the "order limit"—Determining the "rush limit"—The bin stock card—Example—The columns show all the transactions—The original factory requisition—Requisition for standard parts—Requisition for standard parts sent on schedule by stores department—Delivering materials at standard times—Requisition or contract work—The general requisition—This gives control—Character of men or stores work—The perpetual inventory—The checking of inventory by rotation—Keeping down the abandoned stock—Handling this situation—How to find out the amount of abandoned materials on hand—Monthly reports—Discovering the over-bought materials—Use the bin stock card—Report to factory manager—Report rush items to factory manager—Purchasing vs. stores—Unfilled order reports—The factory reservoir—Finished parts stores—Effect of shortage—Operation of finished parts stores—The work limit—The rush limit—Operation of the rush limits—Under-supplies—Report to factory manager, rush list items—

PAGE

Locating over-supplies—The blanket requisition—Loss of time in getting requisition through—Effect of every day's delay—How to control this—The material survey—The checking—The result—Contract work—The conference—The result.

CHAPTER XVI

COSTS 344

The cost department as a cost reducer—Where the cost department should be located—Costs on each product—The problems of costing can be divided into two large divisions—Avoid detail—Direct costs—Methods of issuing tickets—Workmen should not make out tickets—Foreman should make out time tickets—The foreman must know what is going on—Delivery of time tickets to the workmen—The Daily Output Records by operations—Locating the difficulties—Stock tracing—Entering costs—Locating the high costs—Entering of costs in special contracts—Bringing the different parts to assembly together—Comparing costs and estimates—Distribution of indirect costs (overhead)—Why a manufacturer must not spend a useless dollar—The working out of the plan whereby overhead costs are correctly distributed—Danger of incorrect method of distribution of overhead.

CHAPTER XVII

METHOD OF MANAGEMENT BY WHICH OUTPUT IS BROUGHT UP TO THE STANDARDS 360

What is the big factor in success or failure—Body of producers—The Manager must trust to others—The big problem of management—Bringing out the efficiency of the worker—What organization work means—Study the position of the worker—Applying of common-sense-ology—The real governing force in your factory—The governing group—The control the foreman exercises—The foremen should understand the company's policies—The good foreman—Basis of management—The worker's attitude toward discharge—His attitude toward cutting of rates—The employer's side of the rate cutting question—The proper basis—The big problem—The workman resents inequality in wage rates—Promotion should be based on merit—The big problems—The common sense of it all—The American workman—Throwing the conservatives over to the radicals—Remedies—The first step—The second step—The third step—Definite policies to settle—First, cutting rates—Second, day-work rates of pay—Third, labor turnover—Fourth, employment—Fifth, discharge—Sixth, promotion—Seventh, detecting the inefficient and the efficient—Eighth, training—Ninth, wage system—A discussion of the nine points—Arbitrary cutting of rates—The gain in overhead costs that comes through increased production—Equalizing rates of pay for equal service—To handle this situation properly adopt the following procedure—Third, labor turnover—Fourth, employment—Discharge—How these cards operate—When the company keeps no efficiency records—Second step—Promotions—In case the company keeps no efficiency records.

CHAPTER XVIII

PAGE

ORGANIZATION .... 3[illegible]

Developing the governing group of superintendents and foremen—The four essentials—Jealousy and envy destroy co-operation—Lack of suggestions and ideas—Lack of study and training in latest methods—The efficient are not promoted—The problems of effective and efficient organization—The committees—Program—Sample program—The general meeting—Main committees—Subsidiary committees.

CHAPTER XIX

WAGE SYSTEMS 395

Day work—Day work with a minimum hourly production—Piece work—Guaranteed day rates with piece work—The premium system—The bonus system of pay—The graduated bonus system of pay—How to establish my graduated bonus system—Setting earning rates on jobs—The day rate—The bonus—One danger—Graduated bonus system provides for increase pay for increased production—Setting the bonus for production below the standards—Bonus on production below the standards—The way the plan works—The group bonus system of pay—The bonus—Bonuses at lower production—Division of the bonus—Training—Bonuses to job bosses and job setters—Bonuses to foremen—Group bonuses to foremen—The effect—How to introduce new methods.

CHAPTER XX

DETECTING AND TRAINING THE INEFFICIENT 410

Detecting the inefficient—Ratings of workers—Location of inefficient for training or discharge—The effect is always simply electrical—Training of operators—The advantage of this plan—A practical method of training in the shop without a special training department—Using the foremen as trainers—Training of unskilled labor—How we trained 5,000 women—Experience in one factory—The woman beginner's fear and dread—The training department—Careful selection necessary—Only specialized skill is expected—Duties of the job boss—An example of results—Women as assemblers—The general principles—The company's bonus system.

INCREASING PRODUCTION DECREASING COSTS

OPENING STATEMENT

1. THE solution to the industrial problems facing us is to get INCREASED PRODUCTION out of every machine tool, every operator on bench work, every worker on assembling; reduce costs and selling prices; maintain high wages and profits.

Every *machine tool ought* to operate continuously at *full capacity*.

Every *square foot of floor space must* produce its *full quota*.

Every *operator must* produce an hourly output up to standards which will not exhaust him—that represents the result of a fair normal effort under conditions that will insure a high rate of production and of wage.

2. The great surge upward of wages, the tremendous increases in prices of everything that goes into production from the raw materials dug from Mother Earth to the components that make up the finished articles are largely due to world conditions that America cannot control. This condition makes it imperative for us American manufacturers to find out *what* to do to increase production, reduce costs and selling prices, maintain wages and profits—and *then do* it.

WE HAVE SOME THINGS TO THINK OF BESIDES PROFIT

3. In this development we must think not only of lowered costs, lower selling prices and higher profits, but also of the maintenance of a high standard of wage to SATISFY LABOR. Any plan that entails any exploitation of the working man, that reduces his pay—that causes him to work at an unreasonable or dangerous rate of speed in production, must be laid on the shelf and forgotten.

Is the Condition of American Factories Efficient?

4. The big factory managers of this country—men with real shop experience—unite in stating that in the average American shop production can be increased fully 50% with the same machinery and workers. Many place it at a higher figure. My experience proves that 50% is a conservative figure.

The Question in the Manufacturer's Mind

5. The big questions in every manufacturer's mind are—Is it a tremendously difficult job to introduce methods of management that will so increase production and profits, reduce costs, satisfy labor? Will it involve a great lot of red tape system and a ripping up of my organization? Can it be done with the existing organization?

The Answer

6. It is *not* difficult. It does not involve red tape or any ripping out of existing methods or organization. It not only *can* but it *must* be introduced and carried on by your present organization.

We Have Learned Much in Three Years

7. Factory managers have learned a great deal in the last three years. The advances in production methods have literally smashed their way through old inefficiencies of production like giant battering rams. In our intense straining after production! production! In our fights to cut down costs to the last notch, we American manufacturers have forced our organizations to sweep away those old conditions that caused high cost and low production; conditions which were so strongly entrenched that it often seemed hopeless to attempt to conquer them.

8. Those of us who have cleaned house and have gotten our factories upon a real modern management basis have been astounded to find out that these wonder-working methods are so simple; are so full of common horse sense; do away with so much useless system instead of introducing more of it; that they make it possible for the management *to really control* and *direct* the business in all of its details and thus to *force* their shops to meet the requirements of LOW COST, BIG PRODUCTION, HIGH QUALITY, SATISFIED LABOR.

Big Difficulties Caused by Little Ones

9. How has this been accomplished? Simply by recognizing the fact that the big difficulties that hold back the shop and cause such costly delays are brought about by little troubles that were not promptly attended to when they cropped out; then *planning* to catch these little ones when they show up and conquer them *instantly*.

10. The result of a real searching investigation into the causes of delays (if you *do* get the truth) is always enough to make a management ashamed of itself. They will find that most of their shop troubles, delays, and loafing arises from materials not ordered in time nor followed up by Stores and Purchasing, lack of tools and tools and machinery out of repair, lack of accurate knowledge of what outputs should be secured from machine tools and operators, no system of control over the flow of parts through the shop, poor management leaving control of the operators too much in the power of foremen and job-bosses not trained to handle them as the Company would; with big labor turnover due to unjust discharges, unfair promotions, indiscriminate cutting of wage rates, general dissatisfaction with shop conditions, and finally, the tendency of the workmen to loaf on their jobs and beat the Company if they can.

The Problems of Factory Management

11. The problems of factory management may be grouped as follows:

(*A*) Determination of Standard Hourly Outputs

12. The most important factor is the accurate determination of the greatest possible output that should be expected from every machine tool—*every job,* whether done by machine operators, bench workers, or assemblers. This to be determined and a standard hourly output set for each such job that will be fair to employer and employee alike.

13. The writer presents large numbers of tables giving correct cutting speeds, feeds and depths of cuts for various metals on different types of machine tools such as lathes, planers, milling machines, which enables the superintendent to quickly determine these proper standards of output, by using proper accurate standards. All "guess work" and "estimating" is eliminated.

14. There are also illustrated rapid and simple methods of analyzing assembling and bench jobs, and determining the greatest possible output and hence, the standard hourly output per operator without subjecting them to undue strains.

15. There are also established standards for the other departments, such as purchasing, stores, etc.

(*B*) Finding Out What is Being Actually Produced

16. Next in importance is the finding out through simple production reports what is being *actually produced* in the different shop departments. The knowledge of *actual* production gives the management a real control. This can be easily done.

(*C*) Locating the Troubles and Overcoming Them

17. Knowing the *actual* production at every spot, knowing what *ought* to be produced on each operation—the factory manager and superintendent can, by comparing actual with standards, immediately *locate any difficulty* and *remedy* it the *moment it arises.*

(*D*) Control of Flow of Parts through the Shop

18. The controlling and guiding of parts flowing through the factory so that workmen can be kept busy continuously, thus eliminating loafing; and that the parts may reach the Assembling Department in ample time to prevent any stoppage of assembling. This work, when done properly, will keep down to a minimum working capital tied up in work in the shops.

(*E*) No Overbuying nor Underbuying.

19. The securing of materials at the proper prices and storing it in such quantities as not to tie up too much working capital and, at the same time, provide against costly delays.

(*F*) The Handling of Labor

20. The handling of labor from employment to a proper method of increasing individual efficiency, proper plans of promotion of the capable, control of unfair discharges, a wage system that provides a proper stimulus to extra effort and satisfies the worker—all are problems that must be met and solved by the employer.

(*G*) Developing the Organization

21. The development of the latent ability of your real governing force—your superintendent and foremen—so that they will govern the shop in accordance with the management's plans and will work with the management in developing the plans for increasing production.

Your Own Organization Must Do this Work

22. Use your own organization to work out these new methods. These men know better than anyone else what the troubles are and they will rapidly devise methods that will overcome them when the way is once pointed out.

23. They can take the general idea when presented and adapt it to your shop conditions quickly, safely and effectively.

Give Them a Chance

24. Give your superintendent and foremen a chance and watch them grow. Do not find fault with them for past mistakes. Forget these, lay the new plans before them, get their co-operation and help and the road will be smooth and results speedy.

25. It is all a matter of first, finding facts, no matter how unpleasant; then, applying common sense methods to remedy faults; co-operation of the men who can help you—playing fair.

CHAPTER I

REDUCING COSTS—INCREASING PRODUCTION—DEVELOPING EARNING POWER

The Problems of Manufacturing—Average Shop Conditions—The Five Common Sense Principles of Modern Management—Actual Examples of Cost Reduction and Production Increases—Getting the Old Organization Back of the New Methods—How to Begin the Installation of the New Methods.

1. THE great questions that are harassing the minds of the business man and the production man, operating either a large or a small shop, are few in number, are intensely practical, are vitally important. They are simply:

HOW CAN WE REDUCE COST?
HOW CAN WE INCREASE PRODUCTION?
HOW CAN WE MAINTAIN PROFITS?
HOW CAN WE KEEP LABOR SATISFIED?

2. When the average manufacturer goes out into his noisy shop—full of whirring machinery, truck loads of strange-looking materials being hastily carted from one strange place to another, seeing this shop governed by foremen with whom he hardly has a speaking acquaintance—ruled over by a superintendent who is always worried and harassed by a multitude of troubles—it is no wonder that he feels that "production methods" are intricate, difficult, mysterious.

3. It is no wonder that, when he looks at his financial reports, and sees the Company falling behind because costs are too high, production too low, deliveries too slow or production defective, he almost has a feeling of hopelessness when he thinks of tackling the job of putting that shop on a more efficient basis.

4. When he begins a study of many of the deep or complicated systems that look as though they would cost as much to install

as the shop itself and would require a corps of college professors to keep up, his troubles and despair seem to multiply.

5. Now, let us apply to these problems a little common sense, keeping in mind that the modern tendency is toward simplicity, promptness and up-to-dateness and ability to control and direct in a positive manner *every shop condition* and situation.

How Did You Run Your Small Shop?

6. It is not hard for the average American manufacturer who has built up his business from small beginnings to recall what he had to do in that little shop to force success. Now! I will show that all that is needed *to meet any situation* is to *apply exactly those same principles* to his shop when it becomes too big for him to keep in touch with every important situation. Recalling that, for his supervision of the old business—so full of life and vitality because of his self-interest—we must substitute the supervision of others such as the superintendent and foremen who have no such personal interest or personal urge as he had because of their natural lack of self-interest. We must, therefore, always keep in mind that because of this lack of old-time personal supervision in the big shop we must install a real effective system of control over all the others concerned with the management that will be simple, direct, and *force* upon them the knowledge that the management knows what is going on every minute.

No One Had to Tell Him

7. When the manufacturer was running his small shop, with say ten machines and 15 workmen, he needed no system expert to tell him what he had to do to make a success. No one need advise him that his whole fortune depended upon his ability to get a *proper amount of work of the proper quality every day* out of those ten machines—those 15 workmen. Common sense told him that in the first place he had to make his estimates of costs right (as his basis for profit) and then buy his materials at the right price and get the proper quantities in the shop on time. He knew better than to overbuy and so tie up his working capital in useless materials. Then—that he had to see that those men and machines produced at a rate and at a sufficiently low cost to keep him within his estimates—and finally, that he could not allow his overhead expense to eat his head off and ruin his profits. No one had to tell *him* what to

do when those men and machines began to fall down in their production. He *had* to go down the line and find out the reasons, get materials flowing properly here, supply a shortage of tools there, discharge an incompetent worker here, have the foreman show an operator how to do a job there.

8. And when it came time to get an assistant foreman, did he trust to luck and pay no attention to the kind of man selected? Did he run any chance of having one of his incompetent men get the choice jobs while his good workmen grow sullen and discontented because of an unjust selection? Not much! He went over those 15 workmen, their abilities, characteristics, qualities of leadership and past records for good work with a fine tooth comb and when that selection was made, he and his men knew that it was *right*.

9. Whenever the owner of a small shop sees his workmen loaf, the machinery working far under capacity, bad or insufficient materials coming into the shop, customers slipping away because of poor deliveries, that owner can just see his dollars slipping away from him. He knows that he has got to *locate the troubles and then act!* clean them up! or go to ruin.

The Same Principles Apply to the Big Shop and the Small One

10. Now, it is a demonstrated fact that there are these certain things this small manufacturer *must* do in order to make a success and it is furthermore a demonstrated fact that these "same certain things" MUST BE DONE by the big manufacturer also in order to succeed. When he does them, he will surely make a success—when he does not do them, he will surely fail.

11. I insist, and a long practical experience has demonstrated the truth of this, that the *same* principles of modern management and production apply to the *small* shop and to the *large* shop—that the fundamental bases of successful management are ABSOLUTELY THE SAME—the only difference being that in the case of the large shop there must be certain methods and systems installed to take the place of the old personal supervision of the old-time boss himself when the shop was small.

When the "Old Man" Bossed the Job.

12. When the "old man" himself bossed his small shop he ran it upon certain principles (probably without knowing it) that stand to-day as the vital principles of management of any shop, no matter how small or how big. Principles that are the foundation of American manufacturing—the greatest science of production the world has ever known.

13. In the first place, he well knew what his *men and machines were producing* every day and no one could fool him about this.

14. He knew, too, that his *materials* were being *bought right*—at the proper prices—because he attended to this job himself. He saw to it, too, that these *materials* got into that old shop of his *on time* and stopped delays. He made life miserable for any manufacturer who caused him a shop delay and loss of money.

15. His *working capital* was so small and precious to him that he *never overbought,* never found himself tied up financially because of his store-room being loaded up with a big lot of dead and useless stock.

He well knew, too, what prices he shoud pay and what deliveries he could get for his materials so that he could always be certain that he was buying within his limits.

The First Principle of Production

16. Thus he established the FIRST PRINCIPLE of production by always knowing "WHAT WAS ACTUALLY BEING PRODUCED AND WHAT WAS BEING DONE IN EVERY DEPARTMENT EVERY DAY."

17. He soon established accurate data of what his *machine tools* and *workmen* were *capable of producing* when working at a proper speed. He did not have to take any foremen's "guesses" or "estimates" because he knew from actual experience what the output of each part per hour *should be* from each machine and workman, which we will call the "standard hourly output."

The Second Principle of Production

18. Thus, he established the SECOND PRINCIPLE of modern production which is "THE KNOWLEDGE OF WHAT *should* BE PRODUCED BY WORKMEN AND MACHINE TOOLS AND WHAT *should* BE DONE BY EACH AND EVERY DEPARTMENT, i. e., HE THUS, WITHOUT REALIZING IT, HAD WELL-ESTABLISHED STANDARDS."

19. Naturally, knowing the *actual* output and also the *standard*

output that *should* be secured, he always quickly located any shortages in production by making a comparison between what was actually *being* done with the standards of what *should* be done.

20. By following the same process he also located inefficiencies in any other branch of his work. Thus, by making a comparison between *actual performances* and the standards that *should be reached,* he could always locate unerringly the foreman or workman or machine responsible for any error or shortage in production. In other words, he could always put his finger upon the "sticking point." Having located the difficulty, it was a very simple matter for him to remove it, no matter what it might be.

The Third Principle of Production

21. Thus, he worked out the THIRD PRINCIPLE of modern management which is "THE QUICK LOCATION OF ANY DEFECTS, SHORTAGES OR EXCESSIVE COSTS AND THE PROMPT OVERCOMING OF THEM."

22. After he had found out what the standards *should be,* he then watched the different foremen and workmen to see that they were working up to the proper output. If he found a workman working below capacity (which was very often the case) he either discharged him for a better man or else had the foreman carefully teach him how to do the work so as to get his production *up to* the required standards.

23. He soon found out that inefficient, discontented workmen *did not pay*—that the inefficient must be either weeded out or properly trained, and that if the men were dissatisfied for any just cause, that cause had to be removed. In other words, he soon found out that the secret of production lay in:

1. Developing the efficiency of the individual; and
2. Granting to him such conditions of pay as to make him a satisfied worker; and
3. Giving the *good* men a real chance for promotion.

The Fourth Principle of Production

24. Thus, he established the FOURTH PRINCIPLE of modern management which has to do with "BRINGING UP AN ENTIRE ORGANIZATION TO A PRODUCTION BASIS THAT WILL BE EQUAL TO THE STANDARDS AS SET."

25. This old-time boss well knew that he could not get the best out of his foremen and workmen if they were continually

fighting with one another. He soon learned that the old proverb "A House Divided Against Itself Shall Fall" is certainly true of the factory and that nothing is more important in the science of production than getting your organization from top to bottom to work together in a harmonious, enthusiastic manner.

The Fifth Principle of Production

26. Thus, he learned the FIFTH PRINCIPLE of modern production which is "THE DEVELOPING OF AN ORGANIZATION BY MODERN METHODS SO THAT IT WILL BE A HARMONIOUS, CO-ORDINATED BODY OF THE ENTIRE FORCE WORKING TOGETHER FOR THE GOOD OF THE COMPANY."

The Boss Controls the Shop

27. In other words, the old boss was thus actually *controlling* that shop of his because he knew *what* every machine and man *was* producing; he knew *what* every man and machine *should* produce; he could put his finger instantly on any shortage, any shop trouble, and correct it; he weeded out, selected and trained his workmen so as to get only those best able to keep up to the required standards; he developed his small body of workers, foremen and all, so as to get them working together with at least some semblance of harmony and co-operation.

The Same Principles Apply to the Big or Little Shop Alike

28. Now, it's an interesting fact that when the old boss adopts such simple common horse sense methods in his little shop, he is using all the principles and methods that are needed to run with wonderful efficiency a shop with ten thousand workers in it.

29. I have tried them out in three shops of 110, 223, 350 workers, another of 1650, another of 5400 and another of 9600 operators. They work with wonderful effectiveness in both the small and the big shop.

30. As stated before, there is not an iota of difference in these principles whether applied to the big shops or the small ones—only, in the large shops, the system and reports must be developed so as to take care of the multitude of workers, foremen and departments and provide a strong direct substitute for that old personal touch that meant so much when the shop was small.

That Personal Touch

31. We have got to substitute something for that "personal touch" that our fathers used when they made the factory hum and made money at the same time.

32. Your shop *has* to be bound together to you by methods that will enable you to put your finger on failure and efficiency and to punish the one and reward the other.

33. Therefore, the problem of management and production all boils down to these simple things which you, Mr. Manager, will admit you certainly *ought* to know and which you will probably acknowledge that you do not know. Here they are:

1. You have *got* to known what every department is actually producing.
2. You have *got* to know the output each department *must* reach as standards.
3. You *must* locate every breakdown, every inefficiency and remedy them quickly.
4. Your workers *must* reach your standards of production.
5. Your organization must co-operate, work in harmony; your labor *must* be satisfied.

They Will Bring Home the Profits

34. Every hard-headed production man will admit that there is no "fol-de-rol" or "flub-dub" about these five points. They are all intensely practical—properly worked out they will absolutely "bring home the bacon" in *the shape of profits* every time.

35. Every production man, however, knows that these seemingly simple, innocent methods are "loaded"—loaded with hard work, research, investigation, difficulties of introduction, patience in training.

Getting the Organization Back of This

36. Now, if this tough, though money-making job, is to be done properly and is to "stick" afterwards, then the support of your organization has got to go with it. Your shop men, foremen and superintendent *have* to get *back* of it if its to be shoved through to success.

37. While I will bring out later in this chapter my reasons for bearing on this point of co-operation so strongly, still I want

to briefly impress this thought at the beginning, first, because it is necessary; second, because it's *so easy* to get the desired result if you have this co-operation.

38. If your old organization is called in and consulted about your new plans, if they feel that they have a real share in the development of the new ideas—that their suggestions form a part of these—then they will get back of your plans and drive them through to success in a hurry, and your methods and systems will be helped immeasurably, for then, embodied in them are the remedies for the thousand and one little shop troubles that cause the big ones and that only the sub-foremen and foremen know anything about.

Bring Together Experience, Ability and Knowledge

39. Let us then bring together this knowledge of the science of modern production, of up-to-date driving efficiency and the knowledge, ability and enthusiasm of the old organization. Make your organization absorb these new ideas; make them a part of themselves; adapt them, fit them to the factory conditions that only they know so well. Then, and then only, will you get quick, efficient, lasting results.

Suggested Method of Procedure

40. In preparing this book I have arranged the chapters in a sequence which is unusual, but which lays down a regular path of procedure which will bring the quickest possible results.

41. My suggestion to those who propose to carry out these methods, properly modified to suit their own peculiar shop conditions, is to begin by calling together your different managers, superintendents, foremen, sub-foremen and all heads of non-production departments, to consider your difficulties and to devise ways to overcome them.

42. In this body you will usually find one group of hard-headed conservatives who look with distrust upon any new-fangled ideas because of past bitter experiences—sometimes a group who *prefer* to have a system which will cover up and hide their inefficiencies rather than one which will give them glaring publicity—and then a group of earnest enthusiastic men who will "work their heads off" for any reasonable plans the management desires to install.

43. They must all be given to understand that, while their co-operation is desired and necessary, still no half-way measures in putting in needed reforms will be tolerated. .

Use of Committees

44. The most effective plan for quick and *real* results is to form committees (preferably of three and never over five) to consider the different problems. Each committee should report first upon actual existing conditions, and second, ways to improve them. An actual example is always the best illustration. In one shop employing over 9000 operators, I divided the superintendent, foremen, and sub-foremen into temporary committees to consider the following:

(Note.—These points given below, as covered by the committees, represent only a small portion of their work. Full details will be given later, but this brief statement will give an idea of the ground covered.)

Committee No. 1 on Production Reports

45. What is character of present production reports? How reliable? How prompt? How used? Recommendations on proper standards of production reports—how to get them, and how to use them effectively. (See Chapter III.)

Committee No. 2 on Standards of Production

46. What is character of present knowledge of standard hourly output. By this I mean "the hourly outputs that each machine and each operator is *capable* of reaching and what they *should* reach." Recommend plans for determining these STANDARDS. Eliminate from consideration any "estimates" or "guesses." Depend *only* on actual tests. (See Chapter VII.)

Committee No. 3 on Purchasing and Stores

47. Present methods of conducting this work. Report on present methods of getting quotations and placing orders. Report on delays on receipts of materials and reasons; reports on over-buying; over-accumulations of "live" material; quantities of "dead" materials and reasons therefore, etc. Recommendations. (See Chapters XIV and XV.)

Committee No. 4 on Stock Routing and Tracing and Trucking

48. Report on present methods; reasons for delays in delivery of finished parts to assembly department and of material to machining department. Recommendations. (See Chapter IV.)

Committee No. 5 on Production Methods and Shop Arrangement

49. The work of this committee is of great importance. You need not expect to get as quick results on this work as on others. The study will be a lengthy one, but, if pursued properly, will be a big money maker for you. The study of shop arrangement of machinery, benches and operators is in itself a big job worthy of the thought of the best brains in your establishment. (See Chapter XIII.)

Committee No. 6 on Standard Design, Tooling, Tool Design and Machine Tools

50. This committee will study simplification of present designs; making interchangeable parts on your different products; study the tooling in relation to low-cost production; recommend changes on purchases of machine tools of the most recent design.

The Library

51. Naturally your men must be in possession of the facts showing the progress in production methods throughout the United States during the past five years, otherwise they cannot be expected to develop a well-co-ordinated series of modern methods. Therefore, keep a library of the modern books on industrial management and systems for their use. Take plenty of the best periodicals; urge them to use all of them.

52. You will soon find at least a few who are eager to progress and who will study hard on methods adaptable to your shop. Let each study up thoroughly on his particular branch—the purchasing agent on his branch, the stores on his, the production men on theirs and so on down the line. They *must* learn of the principles that represent modern progress before they begin in your shop. A good plan is to let the members of each committee study up,

as thoroughly as possible, on the different subjects coming under them and then hold meetings for the discussion of their own methods, as compared to modern methods several times a week for the two weeks preceding the beginning of this work. Some officer of the company should be present at such meetings as a help and inspiration.

The Use of Surveys

53. In the second chapter I show a number of "surveys" of the different departments. These are made up of a number of very searching questions which *must be answered* by the department head. These answers reveal unerringly the weak spots in each department that *must be overcome.*

54. The following chapters deal with each of these departments in turn showing the modern way of conducting these. Each committee, having before it the report on each department's work can easily discover the bad spots and determine ways to overcome them.

The Average Shop Conditions

55. Modern production engineers all know from their experiences that American factories on the average are operating on a basis that is far below their full production capacities. We know that with the same machine tools and operators, but with improved methods of management, costs can be cut down and outputs can be enormously increased. I am referring not only to the old dirty, dusty shop with old-time equipment and buildings, but also to many modern shops well equipped with buildings and tools but lacking in management and methods that will *get results* from the machines and workers. It is not the fine buildings, equipment and landscape that "brings home the bacon" in the shape of profits —it is *good common-sense management* that does it.

Modern Production Methods Are Simply Applied Common Sense

56. From the past few years of striving have arisen management and production methods that are models of simplicity, directness and effectiveness. Methods that strip away from industry the red tape and bewilderment of complicated systems! Methods that overcome, in a sensible manner, the chaotic condition that

arises from lack of adequate system. Methods that are built upon the old simple principles developed when the shop was a small one, for in anything that is as positive and direct as PRODUCTION there *must* be such simple underlying principles that are the bases for efficiency, whether the shop be small or large.

57. Now any effective methods must be based on strong, simple common-sense PRODUCTION PRINCIPLES that any production man will recognize as sound. The principles given below deal only with PRODUCTION and do not go far afield into realms of sociology, morals, ethics, etc. We endeavor to stick to methods that will bring low costs, high production, increased earning power, satisfied workers and good management. In our study of the small shop we saw that success was built upon five very simple principles. Now let us take these same principles and elaborate and adapt them for big shop management.

THE FIVE PRINCIPLES OF MODERN MANAGEMENT

58. (1) The first principle is "THE KNOWLEDGE OF *actual* PRODUCTION AND *actual* PERFORMANCE IN EVERY DEPARTMENT OF THE BUSINESS."

59. This covers the knowledge of what each department in the plant is *actually* producing, how *efficiently* it is operating and what the products are *actually* costing.

60. This principle deals only with *actual "cold facts"* relating to the operation of the business as a whole, and the operations of each department. In the working out of this principle, it will cover the following:

61. The production manager must know what his *plant is actually producing* day by day, and he must know what are his *actual costs.*

The superintendent must know what *each* of his departments is daily producing.

Each foreman must know just what *his particular department* is getting out day by day, and what the actual conditions are therein.

62. Each head of all other departments that are not strictly production departments must be in possession of *actual facts* relating to the *work* of his department, so that he may gauge its efficiency and note immediately the true situation upon all vital points in his work.

Each and every manager, superintendent and foreman must be able to put his fingers on his "sticking points" each day.

63. (2) The second principle is "THE KNOWLEDGE OF WHAT THE STANDARDS OF OUTPUT SHOULD BE AND WHAT STANDARD OF PERFORMANCES SHOULD BE REACHED IN EACH DEPARTMENT."

64. This means the accurate knowledge of what each department in the plant *should* produce, what the products *should* cost and what standards of efficiency each department should attain.

65. This will cover STANDARDS set for each and every department as the mark of the highest possible efficiency; the mark for all to shoot at; STANDARDS of performance in every activity of factory life. In developing this principle, it covers the following:

66. *A*. The knowledge of what STANDARD production the plant should reach when working at its highest efficiency.

B. What STANDARD production can be expected from each department, when it is working at its highest efficiency.

C. What STANDARD production can be expected from each operator, machine tool, bench work, assembly when working at full efficiency.

D. What is the lowest possible attainable cost, to be adopted as the STANDARD cost, when all departments are operating at the highest efficiency.

E. The STANDARDS of performance that cover all of the vital activities of departments other than those which are strictly production departments.

It is needless to dwell upon the necessity for such STANDARDS as any up-to-date production man knows that without STANDARDS to guide us we are at sea. With the proper STANDARDS before us, we always have the proper mark to shoot at, and can always tell just where the strong points and weak points of our departments are.

67. (3) The third principle is "THE QUICK LOCATING OF ANY DEFECTS, ANY SHORTAGES, ANY EXCESSIVE COSTS, OR ANY OTHER INEFFICIENCIES IN ANY DEPARTMENT, TOGETHER WITH THE PROMPT OVERCOMING OF ANY AND ALL SUCH DIFFICULTIES."

68. This is accomplished by making a comparison between the STANDARDS that *should* be attained and the *actual* performances in any and all branches of the work.

69. Through this we get the *immediate location* of all difficulties of every character, coupled with methods that will overcome these difficulties, whatever may be their character.

70. *A*. These difficulties in the production division may be due to shortage or defects in materials, break down in machinery, defective tools, bad stock routing or tracing; but whatever the trouble,

the methods must locate them immediately and the remedies for these difficulties must be developed.

B. In the TECHNICAL AND TOOLING DEPARTMENTS the troubles may be of a different character, but are of equal seriousness. These must also be located quickly, and cured.

C. In the MATERIAL AND SYSTEM DIVISION it is of equal importance that any difficulties in shortages or defects in material be located quickly, and proper remedies applied at once, for nothing can affect the production department more seriously than to have difficulties and troubles appear in this division.

71. (4) The fourth principle is "THE BRINGING UP (BY SELECTIVE WEEDING OUT AND TRAINING) OF THE ENTIRE ORGANIZATION, INDIVIDUALLY AND AS A BODY, TO A DEGREE OF PRODUCTIVITY THAT WILL BE EQUAL TO THE STANDARDS WHICH ARE SHOWN TO BE POSSIBLE AND AT THE SAME TIME INCREASING THE EARNING POWER OF THE WORKERS AND SATISFYING THEM WITH THEIR WAGE, THEIR CONDITIONS OF EMPLOYMENT AND DAILY WORK."

72. This means that the methods must make the workers satisfied with their wage and working conditions. It will necessarily include methods for handling labor that provide for their proper selection, their thorough training, advancement of the capable, the pointing out of the inefficient for further training or discharge, the reduction of labor turnover and the adoption of a fair wage system that will result in a satisfied body of operators.

73. Each foreman is certainly interested in this portion of the work for it is one thing to find out what your STANDARDS of output should be on each operation; to know how these STANDARDS differ from the daily performances of these operations. BUT it is an entirely different thing to get your operators to alter their old accustomed rate of production and to come up to the new STANDARDS which you will set.

74. This section of the book covers this important question fully and presents ways and means that have succeeded in actual practice in the face of the greatest difficulties.

75. (5) The fifth principle is "THE DEVELOPMENT OF THE ORGANIZATION FROM TOP TO BOTTOM SO THAT IT WILL BE A CLOSELY KNITTED UNION OF THE ENTIRE FORCE—SO HARMONIOUS, SO COORDINATED, THAT ALL WILL WORK TOGETHER FOR A COMMON END, NAMELY, THE GOOD OF THE COMPANY."

76. Now, to most men the idea of getting an organization to work in complete harmony, to really do "team work," may sound like a dream. Every one of you, however, know that an organiza-

tion working upon such principles would naturally prove to be an immense advantage. I can only say to you again, that harmonious organizations has been brought out of those that were full of friction and jealousy; that "team work" has time and again been substituted for friction and "pulling apart." What has been accomplished in the past can be done again.

Actual Examples

77. Undoubtedly, the best illustrations that can be given are from actual examples and therefore, I am giving herewith briefly a few that will prove of interest.

78. The first case was one of a concern employing over five thousand (5000) people in a shop that, on the surface, presented an excellent appearance, both in regard to the shop equipment and the work of the operators. Our investigation made through our surveys showed immediately conditions of very serious inefficiency, the concern facing very serious losses on large contracts out of which they had expected big profits.

Production Reports

79. *A*. We called for the production figures showing daily output. We got "figures" all right!! Tens of thousands of them! Pretty looking reports with nice red and blue lines—and incidentally, over ten (10) days behind and therefore useless. (You can never hammer a shop for an output with your hands full of figures a week late. "The boys" have too many "alibis." The figures have got to be "right up to the *minute*" to be of any use.)

80. We found, too, that—as usual—when the officers got the figures of production they did not know what to do with them. They were simply a big mass of data that could not be digested nor used as a means of hammering the shop into better condition.

81. The trouble in this case was that the FIGURES DID NOT TELL THE STORY OF REAL PRODUCTION CONDITIONS. What a man wants is the statement showing that Bill Jones, foreman of the mill job, yesterday got out a big output with little scrap, but that Tom Smith, foreman of the screw machine job, fell far behind in a way that will surely hurt the output in a week or ten days unless the superintendent gets things moving to overcome this handicap. Reports that make Tom Smith do *some* explaining and make Bill Jones feel proud of himself.

82. But instead of having such useful common-sense material

to work with, this concern simply had one big welter of useless figures. They surely had no knowledge of actual production or of actual conditions in the departments.

83. One report that was gotten out by us in three days after we landed in a shop showed that *somebody* had absorbed $125,000 of the firm's working capital by buying too much of one kind of material for certain parts that were surely headed for the scrap pile as "obsolete material."

84. *B*. When we demanded their standards of output there was a great scurrying around. Standards! Oh, yes! They had them. Why! *They* were the ones upon which they had based their piece-work prices.

85. Yes! said we, but where and how did you *first get* those standards upon which to *base* your piece-work prices? And again, as usual, it proved that they had "first taken their old rates of production under the day-work plan of pay, had figured that a man might increase this production 25% and had calculated their piece-work prices accordingly. Since they made their original calculations, they secured their data for determining later prices by having the foremen "estimate" the outputs. Of course, as is always the case, such output calculations were far too low.

86. As is usually the case, whenever the workers put out extra effort and increased their output and also their earnings, the foremen joyfully cut the prices, thus thoroughly angering the operators and limiting the output through the workers' refusal to increase production because of their fear of a cut in prices. As a result the costs were grossly excessive and output low.

87. We later turned the whole scheme of things upside down, and with the same machines and operators increased the output to over double what it was.

88. This concern simply "had no standards" to go by—no marks to shoot at—and, therefore, were adrift in a sea of ignorance and misinformation.

89. Every few days the assembly department would emit wails of despair because the management was "raising Cain" with them for production and they could not produce because they faced a sudden unexpected shortage of parts. Either the stock tracing department had "slipped a few cogs" or the stores department had not had system and sense enough to get material in in time to meet manufacturing conditions, or away back in the purchasing department they had no follow-up system and some manufacturer did not ship as promised.

90. The amounts of dead unused materials and small tools tied up in the stores were astonishing. Every dollar tied up there (and there were over 220,000 of them) represented tied up working capital that should have been nicely resting in bank decorating the bank balance.

91. Instead of the purchasing, stores and stock tracing departments operating in harmony and properly providing for a smooth system of supplying materials to the shop, they were busy a good part of their time blaming one another for shortages that should not have existed. Important and needed materials were often late in coming into the shop and badly needed parts that were in process of manufacture in the shop could not be located promptly.

92. The tool designing department—tool room and production departments never did agree. The production department complaining that the tools they *had* to use were not properly designed nor made and the other two departments claiming that the production department did not know a good tool when they saw it, and did not know how to use one when they had it.

93. As for labor! It was handled in the usual manner. No one considered for a minute that the *individual* was the one big factor in production. That the big mass was made up of "individuals" and, therefore, "as were the individuals so was the mass." The employees were handled as is usual in the ordinary shop. There was no way to tell the good employee from the bad. There was no way to weed out the inefficient. The employment and selection of workers for the different jobs was usually a matter of luck and guess work. Operators were discharged for trivial causes without knowledge of whether they were good or bad. Promotions were not based upon merit but were in the hands of men who were influenced by favoritism. The wage system, coupled with indiscriminate cutting of prices, was such as to discourage any effort and penalize the fast worker.

94. As a result of all this, here was a shop especially well qualified for low cost and a high production rate in which the production of parts was so low and the costs were so high that not only were there no profits but the most serious losses were being faced. It was simply a "mess."

95 The average business man will say "Yes! That *was* an unusual mess!" But let him take a little time—investigate—and check off those points in this "indictment" that his *own* shop is not chargeable with. Try it and see how perfect you are.

HOW WE QUICKLY REDUCED COSTS AND INCREASED PRODUCTION

96. *A.* We first wanted to find out exactly what each department, each group of machines was *actually* producing—no estimates, no guess work. We could not get this information as we needed it and we could not wait for the results of any system we might install. We had to get *quick* results.

97. We therefore got the old employees busy checking up contents of finished stores and raw stock.

98. We picked out some bright men in the factory who knew the parts and put them with the foremen to make out daily reports of actual outputs of all parts by operations. We did not want to have a lot of forms printed. We drew some up in rough form, had some mimeographed and some blue-printed.

99. As usual, the conditions revealed astounded the management Production on some parts were far beyond the needs. Production on essential parts were so pitifully low that there was at frequent intervals a complete stoppage of assemblage.

100. Some of the hitherto undiscovered causes for this condition were ridiculous. On one small operation two small drill jigs were needed; on another, a few mill fixtures settled the problems altogether; on another, they had 60% more hand-screw machines than they needed, but on the next operation they had 10 thread millers where they needed 16 of them. And on *another* job they were "sweating blood" for hand-screw machines. There was a lack of balance all the way through. And do not forget that on these jobs that were *over-loaded* with machine tools there loafed along contentedly the full quota of workmen.

101. The next step was the investigation and determination of what *should* be produced by the shop on each part; what should be the standards of production. At this point it was interesting to see just how far wrong the foremen were in their estimates of what *should* be produced from the machine tools. Before *starting* to establish these standards of hourly output in a proper manner, I required the different heads of departments to list up what *they estimated* as the production capacity of the different machines on the different parts—desiring to ascertain if they really *knew* what the standard hourly production should be.

102. Now, these men were a capable lot and the average production manager would assume that such a body of men would certainly know their business well enough to give at least an approxi-

mation of the proper standards. It was an actual fact, however, that a comparison between their reports of what *they thought* the standards *should* be and the *actual standards* as determined by *proper methods,* showed that their estimates on the average were only 44% of what was proven later to be the shop's real capacity, and, too, the standards that they set in this report to me were considerably higher than the *actual* production.

103. An example: On one job the operators were producing 12 parts per hour; the foreman reported 20 as a possible maximum; the study of standard hourly outputs made as soon as possible showed that 40 should be the output. The same operators that formerly made 12 parts, after training, averaged over 51 parts.

104. On another important job the average output was 14 parts per hour; the foreman's estimate was 21 per hour; study of standard hourly output showed 32 as a standard output. The same operators reached an output of 41 parts per hour.

105. Similar records were made upon job after job and, as stated above, it was proven that the capacity of the shop was over double that which they estimated. Such conditions made it absolutely impossible for the concern to finish their contract on time and it faced a great loss.

Conditions of Stores Department, Etc.

106. Quick surveys were made of the other departments of the business such as stores, purchasing, stock tracing and costs. These departments showed defects that were undermining the whole concern and yet were not apparent on the surface. Materials were not coming in in time to meet production conditions, this resulting in most serious delays and losses.

107. Specifications for materials were not adhered to and no method of inspection or checking was used, this alone causing endless trouble.

108. The purchasing was not being done in an economical fashion. Delivery dates were not properly adhered to, while the tracing of manufactured parts through the factory was so incomplete and incorrect as to cause great trouble in the assembly department and to the superintendents.

109. It was quite true that the management knew that something serious was wrong, but they did not have the methods that made it possible for them to put their fingers on the "sticking points."

Introduction of Methods

110. The prompt introduction of the methods to be described brought about a complete reversal of these conditions.

111. I emphasize especially that the new methods were introduced with the aid of the old employees. The existing methods were studied and then the improvements, based wholly on the five principles of management, were built upon these. Thus, much time was saved; the men readily adapted themselves to the new conditions because they were so familiar with the essentials, and the old organization gave the whole plan their support because, as their suggestions were asked for and adopted, they felt that "the new system was *their* baby."

112. We immediately established the minimum number of parts on each product that *had* to be turned into the finished parts store room every day in order to keep the assembling room moving constantly. We found a great lack of balance in the numbers of parts already in this finished parts stores so, whenever we could, we stopped the flow of these parts upon which we were overstocked and concentrated on those which were needed badly.

113. We immediately made a survey of the capacity of the machine tools and also the jigs, fixtures, etc., which produced these more important parts, thus determining just at what points we were lacking either machinery or tools. This evening and balancing up was the matter of very first importance. It was done easily and quickly by methods that will be given in detail later. We then built up a simple system of production reports on the existing system of time and job tickets from which the pay roll was made up as these tickets gave us all the data necessary.

114. The stock tracing department was shaken up to its foundation. With renewed authority, the help of the foremen and accurate data as to what was actually needed, we soon had the foremen and stock tracers on their toes. They were greatly helped by the information we gave them and, furthermore, were "inspired" to do their best because they knew that *we* knew what was actually going on every minute. If anyone "fell down" we knew it and knew it *quickly*.

115. The biggest job of all, the determination of the real capacity of the machine tools and operators or the standard hourly output on operations, both production and assembling, were determined rapidly by the methods described later. Care was taken to have the superintendent and foremen together co-operate in this

work. This one job was of fundamental, vital importance, for it clearly and for all time (except when machine tools or tooling are improved) determined their standards of what the different outputs *should* be.

116. The moment we secured our standards of output as they *should* be, and compared these with the *actual* outputs, just that moment could we unerringly point an accusing finger at the department—the foreman—who was the cause of a shop trouble. Locating it, we then found it simple to correct it.

117. We next, concentrating again on the troublesome jobs, trained the operator in the best ways to get out the work, thus rapidly bringing them up from their former low rate of production to a high one. As stated before, on one job the operators were brought from 12 to 51 parts; on another job from 14 to 41 parts; on another job from 22 to 64 parts per hour. The wage system was changed so that the operators made a very satisfactory wage and yet the company got its product at very low labor costs.

118. The material requirements were gone into. Better, more complete specifications developed; better inspection system provided; quantities to carry on hand revised; new and safer purchasing methods installed, and the great mass of dead unused materials, that were such a source of sadness to the management when they discovered the situation, was separated and sold.

119. *G.* Best of all the "old boys" were back of the new schemes every minute and their assistance was invaluable.

120. The one big thing to notice in this case is that the difficulties which were wrecking this large company arose because of neglect of those five common horse-sense principles of ours.

Another Example

121. The writer recently completed a survey of a plant employing eight hundred operatives with which an urgent government contract involving millions of dollars was placed.

122. The old business had ambled along with an old management and an old crew of men who knew every nook and cranny of the shop and who knew or thought they knew where all the materials were located as they flowed through the shop. The management did not know what their output should be. Without proper stores and stock tracing methods, the shop was overloaded with useless materials absorbing a large amount of capital and the assembling rooms were always short of much needed materials.

123. Into this shop was thrown this large contract involving a product containing many hundreds of parts, many of which required a high degree of precision.

124. Owing to the size of the job the designing and making of jigs, fixtures, gages, and perishable tools were contracted for with outside tool shops. The management fondly imagined that the designing of jigs, fixtures, etc, would be capably checked up by these shops to insure accuracy, but, as is often the case, this was not done thoroughly. The result was that 68% of these tools were wrong in some detail, the correction of which caused great delays.

125. As the concern had no adequate system of stores keeping, stock routing or tracing, they soon lost track of materials ordered, delivered and in process of manufacture. The parts being manufactured were out of balance and hence their large and expensive assembling department was idle over 50% of the time owing to shortage of a few parts. Often the shortage was not revealed until they were actually needing the finished part. Then the assemblers would wait until the stock chasers ran around the shop and located the needed parts and rushed them through.

126. As they had not checked tool designs they seldom knew a tool was wrong until they tried to manufacture the part and then, of course, they had to wait until the tool was corrected, often causing a loss of weeks of time. They required a large increase in the number of employees and had no means of training unskilled men and women in their work.

127. The management who, not being provided with records which point unerringly to the location and causes of such inefficiencies, and were therefore ignorant of such business-wrecking conditions, are just waking up to the true conditions, when it is too late. The men in the shop responsible for these conditions were not telling them of these faults and, as they had no system or methods that would jolt them out of their blissful self-complacency by telling them THE FACTS, their troubles became serious.

128. In the midst of this pandemonium appeared a group of expert accountants who installed systems that were beautiful in their complications. The reports that they sent in were so voluminous and so far behind the actual date that they were needed that they were useless.

129. Their wage system was cumbersome and resulted in many inaccuracies.

130. Their methods of making time studies by using inexperi-

enced men holding stop watches on workmen during working hours resulted in the determination of production standards that were so low as to be worse than useless, causing great trouble thereafter.

131. Their routing system which was designed to show where the parts were located in the shop was always from three to five days behind and was, therefore, useless. As a result of this the assembling department was continually short of important parts, this resulting in greatly delayed production.

132. This is a situation that serious as it was, ordinarily is made even more so by the introduction of complicated systems that did not tell the facts, either quickly enough or in such a manner as to make it possible to analyze the troubles and correct them.

133. The methods by which these and other factories were brought up to a state of efficiency will be described in later chapters for the writer believes that the best illustrations are those taken from actual experiences.

134. The methods used are based entirely upon the principles of modern management which, as stated before, include "THE KNOWLEDGE OF WHAT THE PLANT IS *actually* PRODUCING AND THE PRODUCTS *actually* COSTING," "THE KNOWLEDGE OF WHAT THE PLANT *should* PRODUCE AND THE PRODUCTS *should* COST," "THE *location* OF ALL *shortages* IN PRODUCTION OR OF EXCESSIVE COSTS WITH METHODS THAT WILL OVERCOME THE DIFFICULTIES," "THE DEVELOPMENT OF *employees* TO A *high point of productivity* AND SATISFACTION," "THE *development* OF THE *organization* TO A POINT WHERE THE COMPONENT PARTS WORK TOGETHER FOR A COMMON END (THE GOOD OF THE BUSINESS)."

Get the Support of Your Organization and Proceed then to Introduce These Modern Production Methods

135. Again I say that *at the very outset it must be understood that any plans for improved methods must have the support of the organization from superintendents through the foremen down to the job bosses and the operatives.* If these plans are good enough to win their support they will succeed, but if they oppose the plans, then, sooner or later, they are doomed.

136. The reader may wonder why I bear so hard upon a point so obvious, but I have seen so many plans miscarry and fail because of opposition instead of support from this quarter that I cannot emphasize its importance too strongly.

137. So important is "Organization" that I will treat of it in a separate chapter later. However, I have found certain points on this subject so essential to the success of any plans for improvements that statements concerning a few of the salient points must be made before plunging into the main subject.

138. It should be noted that when I refer to "efficient organization" I *do not limit* my plans to the management, but extend it down the line through superintendents, foremen, to include "job bosses" and "labor." No matter how high grade the management may consider itself, a concern with a labor turnover of 100% yearly is *not* operating efficiently and discontented inefficient labor means *high* cost, *low* quality output. Therefore, "Modern Production Methods" must include methods of handling and satisfying "labor," and making it more efficient.

Fit the System to the Factory Conditions—Do Not Try to Fit the Factory to the System

139. Many systems and methods, good in themselves, have utterly failed because the man that introduced them could see only "his system" and he tried to bend and fit the factory *to his systems* instead of shaping and fitting his systems to the factory conditions.

140. Many a system's expert has tried to install an elaborate and expensive system in a shop without sufficient regard to the wishes and suggestions of the factory men *and as a consequence of this he gained for it their enmity.*

141. I recall a typical example, a case where an expert adopted this plan in introducing his methods into an important shop. While he and his assistants were on the ground his mechanism would work fairly well, but after he left the old organization, lacking sympathy for the system, got in its fine work. Their treatment was so effective that inside of three months the man who introduced it would not have recognized the "remains," and the conditions, from the standpoint of efficiency, were worse than before he began. The organization was sincere in their opposition. They honestly thought that the system was poor and they felt that they were not doing anything wrong when they tore it to pieces. In this case, which is a typical one, the production expert simply failed to adapt his system to the factory conditions, failed to gain the sympathy of the organization for his method, and tried to fit the factory to his systems without regard to the good or ill will of the old organization.

The Support of the Organization Must Be Gained

142. We will assume that the factory organization is the usual one of superintendent, foremen, job foremen, etc. Unless any new program is thoroughly explained to these men, their suggestions requested and their support gained, they will naturally look upon anyone attempting to install new methods as an interloper coming in to show the management how smart *he* is and how inefficient *they* are. It is human nature to oppose such a proceeding and factory men are "full of human nature." Such opposition oftentimes is unseen, but its power is felt through a myriad of obstacles quietly placed in the road of progress. The shop men feel that it is quite impossible for an outsider, entirely ignorant of the product, to enter the shop, look around for a few weeks, and then prescribe methods to overcome troubles that are so deep seated that only those who have lived with them can remedy them. Thus, again, at the outset I cannot too strongly emphasize the fact that the co-operation and help of these shop men are very necessary to the quick and full success of any plans for improvement.

143. It is quite true that the company's men, valuable as they are, are usually so busy that they are unable to keep wholly abreast of the times and, therefore, are not always aware of the great advances made in their occupation. Therefore, earnest as they are, they may yet be unfitted to work out by themselves effective methods to remedy the serious faults until they have thoroughly posted themselves upon the modern methods of management that produce such surprising results. In this work the education of the foremen is of the greatest importance.

The Foremen

144. I continually mention the "foremen and sub-foremen" because these men are the most important in the shop, the production and the attitude of labor depending upon the foremen more than upon anyone else.

145. As one example of their importance we must remember that these men are the *real* handlers of labor and that the workers are *directly* under their control. The worker interprets the Company's attitude toward him and his co-workers strictly in accordance with the way that his foreman treats him and his associates. Therefore, the feeling of the worker towards the *company* is actually determined by the foremen themselves, and by the way the worker feels toward these *foremen*. In other words, the fore-

men are the *real factors* in the relationship existing between the employer and employee.

146. As one of the employees who was registering a complaint said: "Mr. Carpenter, don't forget that we operators are under the control of the foremen for over half of our lives when we are awake, and the way they act toward us means that our feeling toward the company will be good or bad." And true it is. The foreman usually determines who gets the choice jobs, the advances, easiest work, most money.

147. The officers issue their beneficent orders and smile in satisfaction over their broad "welfare policy" which is going to work such wonders in improving the relationship between the company and its employees. The orders sift down through the superintendent to these foremen who are the real bosses of the department and the real interpreters of these orders. The concern starts its restaurants, its dances, hospitals, nurses, rest rooms. But somehow these do not seem to have the desired effect and the officials are consequently amazed at the failure of their plans.

148. How are the *foremen* acting? Are they cutting rates of pay on jobs, playing favorites in advancement in position and pay, treating the employees unjustly, or are they operating along broad lines of justice in all these questions that are vital to the man or woman buried amongst thousands away down in the shop?

149. While this question will be dealt with separately later, still, at this point where we are dealing with the importance of the foremen, I must again emphatically say that the operators will regard *the company* as they regard *the foremen* and that their work is affected accordingly.

150. Now, the foremen alone know the intricacies and details of their departments and are usually the men looked to by the superintendent to get the output out without anyone else knowing many of the details.

151. These men are usually the ones who determine the rates of production from the machines (a very wrong procedure) and who, for this reason, in the final analysis determine the actual cost of the output. Their efficiency means low cost—their inefficiency high cost.

152. How necessary it becomes, therefore, to enlist the knowledge and skill of these men who have the real details of the business at their finger's end and are the vital factors with the operators. And, invariably too, their intensely practical suggestions of ways to attain a desired result in their department lead toward

simplicity, directness and low costs. If their co-operation be secured then the new system there becomes *theirs*. They have developed *their* part of it and hence *they* will make it work successfully.

Methods that Will Help the Foremen

153. Therefore, when considering the introduction of new methods, call these men together and explain fully the plans to them. Tell them that these methods are designed *to help them* by giving them prompt and detailed information about the movements of parts in their departments or the development of any troubles therein, and that they are not to be used to check them up and detect their previous shortcomings. Give them a chance to learn of methods used in shops other than their own. Give them the best of libraries—encourage them to meet and talk over matters. *Give them a chance and watch them grow.*

154. Call frequent meetings—form sub-committees to consider the work in different departments. Work up some rivalry among the committees.

155. Give each man personal credit and recognition for what he plans and does, and watch things move. If superintendent or foreman suggests or develops a good idea you see that no one steals the credit away from him—give recognition to him and see him grow in interest and activity. And when you get the superintendent and all the foremen back of a plan these bright men will push *anything* over to success.

156. You may depend upon it that these men have real brains, so give them a chance to show it. If you do, Mr. Manager, you will have some big surprises coming to you when you find some who are fully as smart as you.

157. While the big subject of "organization" will be dealt with later in a separate chapter, let me give here the real definition of "organization" in which every word counts—every word has a vital bearing upon the whole definition:

158. "Organization is 'the systematic union of individuals into a body whose officers, agents, and members work together for a common end.'"

159. That is the *"last word"* on the subject and just so far as your organization fails to meet and fulfill these principles, just so far deficient is it.

160. Therefore, before beginning to introduce the new methods, first make a complete study of your organization and begin to educate your superintendents, foremen, job bosses in these methods and gain their support and co-operation. It is not only "worth while" and well worth the trouble *but* it is *absolutely necessary.*

161. By such methods you get the great benefit of the brains and enthusiasm of your men who really know the production end of your business down to its finest details.

162. Their suggestions, critcisms, co-operation will bring *success.*

CHAPTER II

THE "COLD FACT" SURVEY

Determining the *Actual Conditions* in (*a*) Production Department—(*b*) Assembling Department—(*c*) Stock Tracing—(*d*) Stores—(*e*) Purchasing—(*f*) Costs—(*g*) Inspection—(*h*) Tool and Tool Designing—(*i*) Employment—(*j*) Welfare—(*k*) Labor—as a preliminary to applying remedies for those factors holding back Production.

Let Us Deal with Cold Facts

1. Common sense tells anyone that before beginning the introduction of improvements to increase production and lower costs, we should *first find out what is holding us back*. Like the surgeon we should "make the diagnosis before beginning the operation." The warning to deal only with "cold facts" is needed for too often the manufacturer blinds himself to faults that will sooner or later disintegrate his business. A man too often allows himself to believe only that which he *likes* to believe. He always wakes up some day to find nothing will give a too sanguine optimist such a hard bump as a set of unpleasant facts too long disregarded.

Inspection of Departments

2. Every department of the factory must be investigated to find its strong and weak points. The writer has developed a method by which this is done quickly by preparing a series of questions applying to the work of each department which covers the essential points in its management and methods. The answers to these questions by the head of each department will reveal what methods are being used and will disclose the conditions which are helping or retarding production

Quick and Positive Action

3. When the management has before them these departmental reports they can decide where the weak departments are and what

are the weak points in each, thus making it possible to attack the bad spots first and so save a great deal of time and make the work of improvement much more effective.

The Questions

4. In order to *fully* understand the importance of the questions and their answers, a study of the later chapters which describe the methods, is necessary; yet most of these answers will indicate the strength and weakness of each department immediately. The advantages of making the investigations at the beginning are apparent.

Surveys

5. These questions and answers I call "surveys." They will cover all production departments with output reports and standards of output, handling of labor, method of organization, stock tracing, stores, purchasing, costs, inspection, tooling, etc. All can be typewritten.

Do Not Delegate to Subordinate

6. This is work that should be done by the manager himself. Do not delegate it to anyone else; it is too important. Of course, when investigating the factory departments, do this through and with the superintendent.

Plan of Operation

7. Do not interview your heads by calling them into your private office nor send the forms to them for report, but take your forms with you and go personally into each department, interviewing the heads and assistants *on the spot*. Adopt the "show me" attitude from the start and make them show you every point. Do not listen for a moment to that old time worn song "we are just getting out a system to take care of that which will be in effect next week." I have sung that old favorite myself in a difficult moment and I know how often it is used.

8. It is not necessary nor wise to take a critical attitude in doing all this. You probably have on the average as good a set of men as you could get and you need not put them too strongly on the defensive. If you get the facts, you will find so many things wrong in so many directions that your first tendency will be to blow up, discharge a lot of men, and hammer the rest of

them. I have seen it too often not to know what will happen. And right at this point is where a man must keep cool. You cannot afford to break up your organization and you must make up your mind to adopt a different policy. You have *got* to make good with the men you have got and you cannot do it by scolding and storming. Instead, you must adopt the attitude of helpfulness coupled with the stern determination to improve conditions. The chances are that *they* need a good deal of education and will willingly do all they can to improve conditions if they once learn what you want done.

9. But do not forget that one of the *best* ways to get them to move and move quickly is to let *them* know that *you* know the weak spots in their departments. Always have them keep a copy of this survey. It will make them do some thinking.

10. In my younger days I had a boss who would, after searching interviews, carefully jot down memoranda in my presence (in his little book) of all improvements which "he and I" thought proper. I knew that the boss and the little book would soon appear again, and the way I hustled to get those improvements moving was a caution. When the boss came around again I always had everything moving to show him. But it was his knowledge of *facts* and his *little book* that made me and the other heads of departments push and push hard.

11. There can be no excuse for any head not answering these questions promptly. He *ought* to know the different departmental situations well enough to do so. If he does not then let him get busy and find out the facts in a hurry.

The Production Survey

(To be made out by each superintendent.)

12. Naturally, the production departments are the most important in the whole organization. The other departments such as stores, purchasing, stock tracing, costs, important as they are, are only supplementary to production.

13. A long experience in shop work has proven to me that much of the trouble experienced in the production departments is caused by lax and bad methods in these other subsidiary departments. This survey will therefore show not only the weak and strong points of each production department but also the inefficiencies of these subsidiary departments as they are revealed through their close relationship with the production departments.

Production Survey

14. To Factory Manager: Date................

To be filled out by each superintendent covering those departments under his control. All confidential reports are to be sent to factory manager.

Organization

15. (*a*) Fill out the following form, giving details concerning departments under your control.

(*b*) Give full list of your assistant superintendents, foremen and assistant foremen, giving name, age, service with company, your opinion of their ability as machinists, their salaries, date of last increase. Send in special report on this.

(*c*) Are you satisfied with your organization? If not, send in confidential reports giving complaints and suggestions.

(*d*) Do you call your foremen into conferences? Describe your methods? ....

(*e*) Do you secure new foremen from outside your shops or promote from inside .... Who approves of such promotions? ....

(*f*) Are your foremen working together ....or do they quarrel and show jealousy? ....

Production Reports Showing What Is Actually Produced

16. (*a*) Do you get accurate reports upon production? ....

(*b*) If so, how often? .... Are they always prompt? ....

(*c*) Can you tell from these reports to-day where there was a fall down in output yesterday? .... Why not? ....

(*d*) Can you, from these reports, locate immediately any stoppage? .... Find the reason........correct the troubles immediately .... Can you tell the amount of scrap made? ....

(*e*) If you do *not* get production reports, do you *know* what the production is in each department? .... How do you know ....
....

Determination of Standard Hourly Outputs and Wage Systems

17. (*a*) Do you pay your employees by day work, piece work, premium or bonus plan? ....

(*b*) Are you satisfied with present wage systems? .... If not, send in special report stating why.

(*c*) Do you reduce prices in case of large earnings by employees? .... How is this done? ....
....
What do you consider a fair day's pay and what do you pay tool makers .... machinists .... helpers .... semi-skilled machine tool operators ....bench men .... assemblers .... other employees ....
....

(*d*) How were prices *originally* set in shop when present wage systems were started. From the old day work records? .... or by estimates .... or by tests ....

(*e*) How are prices set now? From old records .... or by estimating .... or by tests .... Who sets the new prices? .... Do you make use of existing tables on cutting speed .... feed .... and depth of cuts for different metals .... Describe how rates of output and pay are set on assembling jobs ....
....

(*f*) If set by actual tests state; if made in shops .... or if made in separate room .... Who did the work? .... Who checked the tests? .... Was test made during working hours or at night? .... What allowance do you make for fatigue of worker? ....

(*g*) Are you satisfied that your standard hourly outputs determined by present methods are satisfactory? .... If not, why not? ....

(*h*) Do your employees restrict their output, refusing to go above certain quantities per hour? .... Why do they do this? ....
Give for each department the average hourly pay (including any premiums or bonuses), also the lowest and the highest earnings?
....

Labor

18. (*a*) What is your labor turn-over for past 12 months? .... What was your labor turn-over for previous 12 months?................ Why the difference?.............. If you cannot answer immediately, then cover by special effort.

(*b*) In what department is the greatest turn-over?........... Why? .... In what department is the least turn-over?....................... Why....................

(*c*) Is your labor dissatisfied?............ Why?.......... .... Are there good reasons for dissatisfaction?........ .... What are they?.............................. ....

(*d*) In what departments is dissatisfaction greatest?........ .... In what departments is dissatisfaction least?........ .... Explain reasons for these conditions............. ....

19. (*a*) Who hires your operators?.................... Are you satisfied with them?...................

(*b*) Do you get the kind you need promply?...............

(*c*) Do you or do you not adhere strictly to the rule of not employing relatives of department heads and assistants?..........

(*d*) Do you employ on foremen's recommendations?..........

Efficiency, Promotion, Discharge, Lay-Off

20. (*a*) Can you, selecting any department, tell accurately who are the efficient workers and who are the inefficient workers? .... If so, how?....................:.

(*b*) Can the foreman do this?............. If so, how? ....

(*c*) When operators are promoted to higher positions, who recommends and who finally approves such promotions?.......... .... Do you feel that efficiency alone determines such promotion?.............. Or is there any danger of favoritism in the first recommendation?...................

(*d*) What method, if any, do you use to fit and train the operators, new to the work, to turn out the standard outputs? ....

(*e*) Who has authority to discharge employees?.............

(*f*) Have you ever had trouble over the discharge question? .... If so, describe briefly.....................
....

(*g*) Do you have rush reasons and slack seasons?......... If so, what is respective number of employees?................. How do you determine who to lay off?.......................

(*h*) Is the shop union or open or non-union?...............

(*i*) Describe briefly any past strikes?....................
....

(*j*) What are your hours of work?........................

Stock Tracing

21. (*a*) Is assembling department ever delayed on account of shortage of parts?....... How often per month does this shortage occur? .... Does it occur regularly on certain parts?.................... What are they?.................. What are the reasons?.............................

(*b*) Do your workmen loaf due to shortage of parts to work on?........... Specify the jobs on which this is worst?....... .... What is reason?..........
....

(*c*) Is this condition due to failure of stores to deliver materials promptly?........... How many times during last 60 days have you been so delayed?................... Report specific cases
....
Send in special report covering question of delays due to stock department's failure to deliver material promptly.

(*d*) What division has charge of stock tracing?............. Does stock tracing department keep up a proper flow of parts to workmen so as to keep them busy?........... What do you suggest about stock tracing department?..........................
....

(*e*) Do your foremen work each day on lists or parts showing what is needed?......................... If not, how do they know what to work on?...................... Are parts continuously rushed through the shop?................... Special report giving reasons and your remedies.

Tooling

22. (*a*) Are you consulted about tooling?......... Are you

satisfied with it?................ What jobs need new tooling to produce more work or better quality?........................ Send in special report covering suggestions.

Scrap

23. (*a*) On what jobs do greatest scrap occur?..............
....
What is reason for excessive scrap? Bad tooling............or too close tolerances............or poor machine tools........... or poor operators................any other cause............... How can scrap be reduced? Send in special report on this.

Small Tools

24. (*a*) What steels do you use for small tools?..............
....

(*b*) Have you a standard method of hardening............or does your smith harden as he pleases?........................

(*c*) Do workmen grind tools............or automatic grinder ....

(*d*) Have you determined standard clearance and lip angles ....back and side slope............or do your workers grind tools to suit themselves?..................

(*e*) What are your standards?............................
....

Lubrication

25. (*a*) Do you lubricate by the usual method of a small stream ....or do you use a flood of lubricant?.............. What lubricants do you use?.................................
....

Machine Tools

26. (*a*) Are you satisfied?.................. Special report on needs.

(*b*) Describe briefly machine tool arrangement...............
....

Materials

27. (*a*) Is quality of materials satisfactory?................

What materials are not satisfactory?..........................
.... Why?......................................
....

Costs

28. (*a*) Can you get detailed operation costs from cost department that will show clearly those operations upon which the labor cost appears excessive?.......... Why not?..................

(*b*) Do you get each month from cost department analyses on jobs costing excessive amounts so as to get after them and effect economies?..............

29. How can the management help you to operate your department up to full efficiency?..........................
....
....
....

Assembling

30. When this report is filled out by a superintendent of assembling, the following additional data are required.

31. Send in copies of all forms used by you.

Method of Assembling

32. (*a*) Describe briefly method of assembling..............
....
....
Do you use sub-assemblies?.............. Do you use progressive assembling?.............. What special methods have you for conveying materials from one assembler to the next?........
....

Delays on Deliveries

33. (*a*) Do you suffer delays because of not receiving parts on time from finished stores?...................... How many delays in past 60 days?.................. What particular parts cause most delays?..
....

Production

34. (*a*) Send in iist showing *daily completed production* for past 30 days. Make this out for each day separately.

Inspection

35. (*a*) Do your parts come to you within the allowable tolerances?................. Name parts that cause you the most trouble...

(*b*) What ones do you have to file or fit?....................
....

(*c*) Describe system of final inspection.....................
....
....

Who has control of final inspection?......................

Sales Department Complaints

36. (*a*) How many complaints have you received from sales department and customers the past 90 days?.............. Describe briefly their character..................................
....
Also cover this in special report covering all defects as they affect your work.

37. Send in copies of all forms used by you.

38. How can the management help you to get out more and better production?..
....
....

(Signed).................
Superintendent.

Cover All Phases

39. This survey, while lengthy, can be filled out quickly. Dealing as it does with the head governing force of your shops—the superintendent—it must naturally cover all phases of his management.

Replies Invaluable

40. The replies on this survey will prove invaluable as they will, when propertly analyzed and understood, unerringly point out the bad spots in your management and system.

(*a*) The superintendent's statement relative to his production record will show whether or not he knows what is being *actually produced.*

(*b*) His covering of the question on wage systems will show

if cutting of rates prevails with all its attendant labor troubles; if the wage system is a proper one; if the standards of output, so *vitally* important to the manufacturer, are determined upon a sensible accurate method or upon the usual mischievous costly methods of "guess work" or "estimating."

(*c*) The replies under Labor will tell an important story. From these you can judge some of the real underlying causes for labor inefficiency and dissatisfaction.

They disclose whether or not any knowledge exists as to the efficient operators as differentiated from the inefficient and whether anything is done to make the poor producers any more efficient.

(*d*) The replies on stock tracing and stores are important for they disclose whether or not shop inefficiency, delays and loafing are due to the laxness that is so common in these two important departments. These deserve special consideration for if stores and stock tracing do not operate efficiently, then shop production is reduced and costs mount up invariably.

(*e*) The sections on tooling, scrap, machine tools, material, costs and assembling, each will tell a story of proper or improper methods which will have a direct and unvarying effect for good or evil on the ultimate production.

Discloses Where to Start to Conquer Inefficiency

41. As stated before, a study of these questions and answers right at this point is necessary. While, of course, a reading of the following chapters will illuminate the problems raised and will show how they can be conquered, still, any first-class factory manager will understand the story when once he has gone over these surveys. With these, he, with his superintendents and foremen, know where to hit inefficiencies first.

42. When there are a number of assistant-superintendents then each one must make out this report covering the departments under his jurisdiction.

The Foreman Survey

43. The following survey is to be filled out by each and every foreman—by the foremen personally and not by any substitutes. While the ground covered is much the same, still it is necessary that each foreman see these questions, study them, answer them himself so that they will sink into his mind and he can appreciate his problems of management.

44. The replies of the different foremen will differ and you will thus get an excellent idea of their conception of management and how each one is handling vital problems in his own department. *You will always find a great difference in methods between the different ones and also a decided variation from the management's policies interpreted as they usually are by the foremen without specific instructions and according to their own desires.*

45. These questions and replies that the foremen *must* make give them something to think about. And think over them they do, with valuable concrete results in the way of prompt improvements.

46. Insist that the foremen answer promptly. If they cannot answer a question, then have them put down "don't know," and then have them learn the facts.

Foreman's Survey

47. To Superintendent: Date................
Name of department.............................. Name of foreman........................ Age...... Salary......
Assistants' names, ages, salaries...............................
....
Total number employees: Men........ Women........ Number skilled workers......... Semi-skilled (requiring job setters) .... Unskilled........ Number job bosses, if any........
American workers.......... Foreign born........

Labor

48. (*a*) Are you satisfied with the class of employees sent you? .... If not, state why..............................
....
Are operators employed on your recommendation?..........

(*b*) Have you any facilities for breaking in or training the new operators?........... If so, give brief description.........
....

(*c*) What is your estimate of the length of time required, on the average, to break in a green operator to reach the proper output?...........................

(*d*) Does the company provide any means by which you can pick out your efficient and inefficient operators?................

If so, what is it?.......................... How, then, do you tell the good from the bad?...............................

(*e*) Do you operate on day work.............or piece work ....or premium.............or bonus?............ How many rates (approximated) have you on work coming through your department?............... How were the wage rates originally set: From old day work records?........or estimates?............or actual tests?................ If by tests, then describe how tests were made............................ .... How are rates set now?.................................... .... If by estimate, who makes them?........................... If by tests, how and where are they made?.................... ....

(*f*) What is average rate of pay in your department (approximately)?........... What is lowest amount earned?.......... What is highest?........... When earnings become excessive, do you reduce the wage rates?........... What method do you use to determine how much to reduce them?................... .... How many rates have you reduced in the past 90 days (approximately)?...............

(*g*) Do your operators restrict their output?........... If so, why?....................................... Does your labor appear satisfied.........or dissatisfied? If latter, then why? ....

(*h*) How many new employees in past 60 days?........... How many discharged in past 60 days?........... What were main reasons for discharge?............................... How many quit of own accord?.............. Can you give any reason for this?.......................................

(*i*) Who has authority to discharge employees?............. Who recommends promotions?....................... Who acts finally on promotions?.......................... How do you determine the relative worth of your operators when considering promoting one of a gang?.........................

Tooling

49. (*a*) Give list of jobs which can be improved in quality or

quantity by better tooling..

....

(*b*) Are you consulted on tooling?........................

(*c*) Are tools under repair returned promptly?.............

(*d*) What jobs have you that need additional jigs or fixtures to get out required output?..............................

....

(*e*) Do you get plenty of perishable tools?.................

(*f*) Do your workmen grind their own tools?........

(*g*) Have you any standard for lip and clearance angle...... back and side slope?.......... If so, what are they?............ ....

(*h*) Are tools so hardened as to be of uniform and good quality?..................

(*i*) How long, on the average, will they run before needing regrinding?......................

Lubrication

50. (*a*) What lubricants do you use?...................... What volume per minute do you use................. Do you use flooding lubrication by which large volumes of lubrication are flooded on the tool and work?...................... If so, with what results?....................................

Stock Tracing and Stores

51. (*a*) Do you have many cases where materials have to be rushed through your department in order to get to assembling room in time?.............

(*b*) How many cases in past 60 days (approximately)?........

(*c*) Name any parts upon which this RUSHING seems to be chronic?.. .... Why is this?................. ....

(*d*) Are you told what jobs to start each day..........or is this left to your judgment?..................................

52. (*a*) Are you kept supplied with ample materials.......... or do your workmen run out of work often, this resulting in loafing which canot be controlled?...................................

(*b*) What remedy do you suggest?........................ ....

(*c*) Are your materials properly inspected?.................

Name those giving you trouble.................................
....

Supplying Work to Workers

53. (*a*) Describe briefly your method of getting jobs up to the operators ....
....

(*b*) Do operators have a new job, with tools and instructions all ready, by the time the old job is completed?................

(*c*) Is workman's time and job ticket satisfactory?..........

(*d*) Who makes these out?...............................

(*e*) Are tickets made out when *each job is finished?*..........

(*f*) Or do workmen wait until end of day and then make them out?.........................

54. Give a list of what you consider your biggest troubles, so that working together we can overcome them...................
....
....
....

(Signed)....................
Foreman.

THE SURVEY OF STOCK TRACING

Work of a Stock Tracing Department

55. The control and guiding of the flow of materials through the shop is one of the important functions of management. Upon this efficiency of this department depends the constant supply of parts to the assembling department so as to stop all delays—the regular flow of materials to every department, to each operator so that workmen will be kept busy—the reduction to a minimum of parts in process of manufacture so as to relieve all working capital possible.

56. Nothing touches so closely the work of each department as this department and it deserves especial attention.

The Stock Tracing Survey

57. To Factory Manager: Date..............

(*a*) Describe briefly your present system...................
....

....
....
....

Starting Materials

58. (*a*) How are you certain that materials are started at the proper time?..................................

(*b*) Do you depend upon the foremen to issue requisitions when they need materials, or are these materials sent into the shop by the stores department at stated periods, so that they may be certain of getting through in time?..................................

Routing

59. (*a*) Have you, in writing, a routing of each part manufactured?...................

Authority

60. (*a*) Have you the authority to guide the movements of parts through the factory?................. If so, do you report directly to the superintendent, or directly to the foremen? ....

(*b*) Who are you responsible to?.........................

(*c*) Do the foremen promptly execute your orders to get out parts quickly?..................................

Finished Parts Stores and Assembling Room Delays

61. (*a*) Do you operate a finished parts stores between the machining department and the assembling?..............

(*b*) If not, how do you keep the assembling room supplied? ....

(*c*) If so, how do you establish limits in the Finished Parts Room?..

(*d*) How do you know when certain parts should be operated upon by the foremen, and when they should be rushed?.......... ....

(*e*) How many items were on the rush list in the last 30 days?........... In how many cases were the assembling room delayed on account of shortage of parts?.................

(*f*) Who was at fault?.................................. ....

(*g*) How long were the delays?.....................

(*h*) Are you satisfied that everything possible is being done to insure deliveries of parts to the assembling department?.......... ....

(*i*) In what departments do most of the delays occur *regularly*, and why?..

(*j*) What are the parts that show the greatest delays in the past 60 days?.. ....

(*k*) In what departments have these delays occurred?........ .... Upon what operations... Upon what machine tools?...

(*l*) In case you ascertain what the assembling department needs, how do you locate the needed parts?............................ ....

(*m*) Do you issue written instructions to the foremen covering what they should work on during the day?............... How early each morning do you notify the foremen what to work upon?......................

62. Give list of members of your department, their duties, names, ages, salaries.. ....

SUGGESTIONS

63. (*a*) What improvements can you suggest in either the type or the quantity of machine tools?............................. ....

(*b*) Tooling.. ....

(*c*) Supply of materials................................ ....

(*d*) Give your suggestions on how to improve conditions in every possible direction in order to keep material flowing through the shop, keep the workmen busy, prevent delays on material delivered to the assembly department?........................... .... Send in special report if necessary.

SURVEY OF STORES DEPARTMENT

Stores Survey

64. The functions of the stores department are of great importance. This stores department, together with the stock tracing, which has charge of the work in process of manufacture, form the company "factory bank" in charge of the greater part of its working capital. If these two departments are run well, then the company's working capital that is tied up in materials is reduced to the lowest possible point. But if too much material is ordered and kept on hand—if there be a big accumulation of dead stock, if the scrap is not handled right—then large and unnecessary amounts of working capital are tied up tight in the shop that ought to be in the shape of CASH in the bank. It must be clearly understood that $10,000 tied up in useless stores is far worse than $10,000 lying unused in the bank, for the $10,000 in the bank is always good, while the $10,000 in useless stores is very liable to be lost entirely through the necessity for scrappage. It therefore is important that the stores department watch all of these points mentioned as being in their charge.

65. The stores department should have charge of:

(*a*) Ordering of materials from the purchasing department, and keeping up stock. These orders must be placed in sufficient quantities as to insure a steady flow of materials into the shop and provide that enough should be on hand at all times, so that the purchasing department may have ample time in getting new supplies in.

(*b*) At the same time, working capital must not be tied up in too large accumulations of materials in stores. This is dangerous, not only from this standpoint, but also in case any parts must be abandoned through change of design, or abandonment of the products.

(*c*) The stores department should watch at all times the question of dead stock, and see that all accumulations are reported promptly to the management, so that they can take whatever action they may see fit.

The Stores Survey

66. To Factory Manager: Date................

Order Limits

(*a*) How do you determine your order limits by which you should place orders with the purchasing department?...........

....

(*b*) Have you a rush limit, and, if so, how is it established?

....

(*c*) How do you follow up the purchasing department on rush orders?...

....

Rush List

67. (*a*) How many items are now on your rush list with the purchasing department?..............................

(*b*) What items caused you the most trouble through shortage during the past 60 days?.......................................

....

(*c*) What items are you in serious need of now?............

....

(*d*) Why did shortages occur during the past 60 days?........

....

(*e*) What do you recommend to overcome shortages?........

....

....

....

Requisitions

68. (*a*) Are you satisfied with the requisition system?........

(*b*) How long does it take before a requisition sent out by you comes back properly O. K'd.?......................

(*c*) Do you give out anything without a requisition?..........

(*d*) Do you deliver materials to the factory necessary for production, on a requisition, or at stated intervals?..............

....

Bin Cards

69. (*a*) Do you run bin cards, showing receipts and deliveries? .... Do you keep them up faithfully?.............

(*b*) Do you record receipts and deliveries promptly?..........

(*c*) How do you handle materials that can not be carried in bins?..

(*d*) Do you keep up a set of records in the office?............ If so, do you keep up the bin cards also?..............

(*e*) Do you find your office records wrong because of lost requisitions?.................

(*f*) Submit samples of all the forms and cards that you use.

(*g*) Do you keep a perpetual inventory?............ How do you check it?............................... Do you find any errors?....................

(*h*) Did you ever try inventorying a certain number of bins each day, doing this work when not busy at regular duties, so that by end of month you have checked up everything?..............

(*i*) If not, how do you check up?.........................

(*j*) If you have not done this in the past, can you do so now? ....

(*k*) How many unfilled orders have you out?.......... A special monthly report should be made of this, showing unfilled orders, monthly consumption, and on hand.

(*l*) Are you satisfied that you are not over-supplied on some items?................ If you think you are over-supplied, please report same...............................

(*m*) Report all items for which you have not had to place any orders for 30 days.. .... For 60 days........... ....

Abandoned Stock

70. (*a*) Send in special report covering in detail all materials that you consider abandoned stock.

(*b*) How many such items have you?......................

(*c*) How many items have you for which you have had no calls for 60 days?.............

(*d*) Have you any outstanding orders for such materials?......

(*e*) Are you notified when sales department or factory is considering any changes?...........

(*f*) Do you have the opportunity to get materials into shop and cancel outstanding orders *before* changes are made?..........

(*g*) Report separately number of such cases occurring in past 6 months, showing amounts of materials involved.

Scrap

71. (*a*) Who notifies you when the scrap is ready to be sold? .... Do you alone sell scrap?........

(*b*) How do you handle scrap?...........................
....

(*c*) Is there any check on the scrap that is reported by the factory departments?...................

(*d*) How do you check up the amount of scrap received by you, against the amount of scrap as sold, for which the company receives compensation?.................................
....

(*e*) How do you handle the scrap which is to be returned to the manufacturer and charged to him?........................
....

(*f*) What character of reports do you make on the question of this scrap?..

Receiving Department

72. (*a*) How do you handle the receiving department?........
....

(*b*) Do you inspect raw materials?............. Have you full and proper specifications, together with such gauges and other measuring instruments as to enable you to properly inspect material received?....................................

(*c*) How do you handle goods that are to be returned so as to insure company getting credit for them?.....................
....
....

73. Are you satisfied with the stock systems?................ Please send in suggestions as to how to improve these?..........
....

74. Please make special report on small tools and general supplies advising

(*a*) If you think ordering limits are right.
(*b*) Are you overstocked and where?
(*c*) Do you think there is any waste that ought to be stopped?
(*d*) Give your best suggestions.

Send in copies of all forms.

Report on number of employees, giving duties, names, ages, length of service, salaries, previous experience.

What do you consider your worst troubles to be?...........
....
How can the management help you?.......................
....
....
(Signed)...................
Head—Stores Dept.

SURVEY OF PURCHASING DEPARTMENT

75. The principal functions of a purchasing department:
  A. Buy material at the lowest prices consistent with desired quality and service.
  B. Buy materials in proper quantities—neither under nor over-buying—so as to properly conserve working capital.
  C. Buying materials strictly to specification—must be neither of inferior quality nor of too high quality, thus affecting prices.
  D. All materials *must be gotten into shop* within a determined time so that there may be no possibility of delays.

NAME OF 10 MOST IMPORTANT PURCHASES	YEARLY PURCHASES				FROM WHOM BOUGHT	LOCATION	QUOTATIONS GIVE NAMES & QUOTATIONS OF 3 COMPETITORS						EXPLANATIONS
	THIS YEAR		LAST YEAR										
	AMOUNT	PRICE	AMOUNT	PRICE			NAME	PRICE	NAME	PRICE	NAME	PRICE	

FIGURE 1.—Form to be Used in Making Survey of Purchase Quotations

76. It, therefore, becomes most important to consider the purchasing department from the standpoint of:

A. Quotations;
B. Quantities ordered;
C. Specifications of material;
D. Deliveries on time.

QUOTATION SURVEY

77. This survey should cover 10 of your most important purchases. In case you have less than 3 competitive quotations, still

fill out the columns with competitive names, leaving quotation column blank.

Form

78. A form to be used in making the quotation survey of the most important purchases is given in Figure 1 on the preceding page.

79. It should be noted that this form when filled out will show if the purchasing department is diligent in getting quotations on important items, and also show if best prices are being secured.

80. Give names, duties, salaries, age, length of service of members of your department?..
....
....

81. Report on all items on which you can show a saving this year over last...
....
.... Also all items on which increases have been paid and why..
....
....
....

Purchase Orders

82. (*a*) Describe the method of placing purchase orders......
.... Who approves them?.......
....

(*b*) Can you purchase small materials quickly, or are you tied up by your system?...........................

Requisitions

83. (*a*) Do you buy only on requisition, or do you buy without requisition, and why?..
.... Who approves your requisition?........
....

(*b*) Do you consider the requisition safe, and are you satisfied that these requisitions come through to you as fast as possible?
....

(*c*) How long does it take for a requisition to reach you after it starts from the stores department?.....................

(*d*) Do you always get notices to buy, and the necessary requisitions from the stores in ample time to get materials in?..........

If not, report fully what items you have troubles on?...........
....
....

Rush Items

84. (*a*) How many items did you have to rush into the shop within the last 60 days, and what were they, and why?..........
....
....

(*b*) Where there any serious hold ups?..................

Follow Up System

85. (*a*) Describe briefly your follow up system.............
....
....

(*b*) How often do you follow up items?............

(*c*) How far ahead of the shipping date do you follow up the shipper?................ Who attends to this work?......
....

Quotations

86. (*a*) Describe your system for getting quotations..........
....
....

(*b*) Do you check these quotations against the market quotations in newspapers and in trade papers? .... Are you satisfied that you are getting the lowest trade prices?............ If not, why?..

Specifications

87. (*a*) Have you complete specifications on all materials? ....

(*b*) Would any changes in these specifications enable you to buy material more cheaply, or get it quicker?............ If so, what changes will accomplish this?..............................
....

Dead Materials

88. (*a*) Are you notified promptly when any type of material is abandoned, so that you can cancel outstanding orders?.......... Are you satisfied that we are not piling up unused material, and

so tying up working capital?............ If you think we are doing this, please send special report.

Filing System

89. (*a*) Describe your filing system.........................
....
....

90. Give a list of all unfilled orders on special report. Give your suggestions as to what can be done by the management to improve conditions, so that your department can do better work.
....
....

91. Give statement of the most serious troubles you have in your department...
....
....

92. Give your suggestions as to how the work in your department can be improved. (Include in this your suggestions relative to personnel.)..
....
....
....

Please send in copies of all forms used.

(Signed)...................
Head—Purchasing Dept.

Survey of Cost Department

93. My conception of a real cost department is one that plays a vital part in the management's efforts to cut down costs—not one that simply piles up masses of figures that no one looks at or uses. A cost department is invaluable if you use it as a *tool to get cost reductions.* All through this cost survey the reader will see that the questions lead toward analyzed data that will enable the management to *reduce costs.*

Cost Survey

94. To Factory Manager: Date................

Costs vs. Estimates

(1) (*a*) Have you an estimated cost on each of your products? ....

(*b*) Do you ever revise these estimates?...........

(*c*) Do you ever compare your actual costs with your estimates?...............or send your manager a monthly report giving comparison between costs (direct and overhead), estimates and sale prices?.............

(*d*) How were your sales prices set?.......................
....

(*e*) How are they changed when costs go up?...............
....

95. (2) Send the manager the following information at once on each product in a special confidential report:

(*a*) Original estimate in detail.
(*b*) Original sales price based on this estimate.
(*c*) Your present costs in detail (include overhead).
(*d*) Your present sales price.
(*e*) Set up also a comparison showing your competitors' prices on the same product. The sales department can do this if you have not the data.

Cost Products

96. (*a*) Do you send the management a report on costs of each product every month?........... If not, what is the reason?
....
....

(*b*) How far behind are you in your cost entries?...........

(*c*) What is needed to enable you to keep them right up to the minute?...
....
....

Use of Cost Records to Locate High Costs

97. (*a*) Does your management ever use your cost records as a means of reducing costs by locating through you the high costs and going after them?.........................

(*b*) What superintendents and foremen call for your detailed labor costs in order to ascertain high cost operations and reduce them?...
....
....

(*c*) Send in report giving the 10 operations on each product that show the highest labor cost.

(*d*) Suppose the management found a competitor underselling the company on an important product.

Suppose they call for the costs in full detail; all materials and every item of labor down to each operation; the proper overhead allowance; their object being to force a reduction in costs to meet the condition. Under such conditions can you hand them this for say, the preceding month INSTANTLY and the up-to-date figures in two days?............ If not, why not?...........

....

....

How long would it take you?................

FORMS

98. (*a*) Send in your forms covering material costs and describe briefly your system.....................................

....

....

(*b*) Do you get material requisitions from stock room promptly? ....

(*c*) Are they ever lost?............

(*d*) How do you put the work into process of manufacturing?

....

....

....

....

(*e*) How do you handle labor tickets?.......................

....

....

(*f*) Are you satisfied that these are correct?..........

IS PRESENT SYSTEM SAFE?

99. (*a*) Is there *any* chance of a workman getting paid twice for the same job?........... Or two workers getting paid for the same job?........... Or a worker getting paid for a fictitious job?...........

(*b*) How do you check a worker's time of entering and leaving the shop as shown on the time clock against his job tickets?........

....

(*c*) Do you balance your cost entries against payroll as a check on each?......................

(*d*) Can one workman ring up the time clock for another? ....

(*d*) Can they manipulate your time-checking system in any way? ....

(*f*) Do the workmen in making up their time job tickets report correctly the time of starting, stopping work on each job so that you can calculate costs correctly, or do they simply make out their job tickets at the end of the day and *guess* at the proper division of total time amongst the jobs? ....

Wage Systems

100. (*a*) Does the shop operate on day work..........or piece work..........or premium..........or bonus?..........

(*b*) Please describe this in a special report, advising especially if you consider the tickets properly checked.

(*c*) Send in your suggestions on wage systems.

(*d*) Do the foremen reduce rates when workers earnings become large?.......... How many reductions in past 4 months? .... Report by departments............................
....
....
....
....

Scrap

101. (*a*) Describe how scrap is handled from time it occurs in factory until it is sold and leaves shop..........................
....
....
....
....

(*b*) What check is there between scrap actually made and scrap sold and money secured therefor?..............................
....

Labor Costs

102. (*a*) How do you enter your labor costs?................
....
....
....

(*b*) Please send forms.

Suggestions

103. (*a*) What do you suggest that the factory departments do to help your department?..................................
....
....
....
....
....
....

Overhead

104. (*a*) How do you calculate your overhead—by percentage on labor costs..........or by percentage on labor hours.......... or by percentage on material plus labor..........or by machine rate distribution?..........

(*b*) Do you use departmental overhead?..........

(*c*) In case you use the percentage system do you distribute the same percentage on each product?............

(*d*) Considering the differences in investment required (land, floor space, machine tools, tools, etc.) together with a division of taxes, insurance, and other overhead charges which ought to be charged according to a proper division of the above charges against your different products, are you satisfied that your method of overhead distribution is correct?..............................

(*e*) Suppose you had your different products in separate shops with their differing requirements for floor space, machinery, tools, heat, light and power, taxes and insurance, superintendents, etc., would you still distribute overhead as you are now?..............
....

(*f*) Will your present method lead to an improper division of overhead distribution?........... Will it affect selling prices? .... How will it meet the conditions when a competitor is making and selling only one of these products that requires only a comparatively small overhead?..............................
....
....
....

Special Reports

105. Please submit to your manager a special report (giving approximate figures only) covering the following:

(*a*) Actual factory floor space.
(*b*) Yardage space used for stores.
(*c*) Total valuation of machine tools.
(*d*) Total valuation of special tools.
(*e*) Total-valuation of small tools.
(*f*) Total valuation of stores.
(*g*) Total valuation of work in process.
(*h*) Total valuation of finished stock.
(*i*) Total cost of heat, light and power.

106. Now prepare for *each separate product* a report covering approximately:

(*a*) Floor space required.
(*b*) Yardage space required.
(*c*) Valuation of machine tools used on this product.
(*d*) Valuation of special tools used on this product.
(*e*) Valuation of small tools used on this product.
(*f*) Valuation of stores used on this product.
(*g*) Valuation of work in process.
(*h*) Valuation of finished stock.
(*i*) Cost of power.

107. Give full report covering your suggestions how the management can help to make your department a vital center for cost reduction.

Give names, dates, ages, length of service, salaries of the members of your department.

108. What are the things that are causing you the most trouble?

....
....
....
....
....
....
....
....
....
....

(Signed)....................
Head of Cost Department.

Survey on Inspection

109. The need for inspection varies with the character of the work. Usually inspection will pay for itself over and over again for it, if properly done, will insure the parts coming correctly to the assembling department thereby reducing the labor there. When the work is close, then rigid inspection is necessary.

Inspection Survey

110. To Factory Manager: Date..............

(1) (*a*) How many employees?..... Men.....Women.....

(*b*) Report rates of pay with number affected?..............

....

....

....

(2) (*a*) Do you inspect raw stock as well as parts in process of manufacture?...........

(*b*) How many gaging and inspecting operations have you? ....

(3) (*a*) Do you have absolute authority on rejections?.......

(*b*) Who can over-rule you?........................

(*c*) How many times did this happen in last 90 days?.........

(*d*) Report briefly the last five (5) cases....................

....

....

....

....

....

(4) (*a*) Do you ever pass parts that are over the tolerances? ....

(*b*) Why?..................................

(5) (*a*) Does the assembling department complain of parts passed not being kept within tolerances?.................

(6) (*a*) What are the parts that are hardest to hold to your gages? ....

....

....

(7) (*a*) On what parts do you have the greatest scrap, and why?

....

....

....

....

(8) (*a*) To how many parts do you give 100% inspection?.....
(*b*) To how many parts do you give 50% inspection?......
(*c*) To how many parts do you give 25% inspection?......
(*d*) To how many parts do you give 10% inspection?......
(9) Give your suggestions as to possible improvements that will improve quality, reduce scrap, increase output..................
....
....
....
....
....
10. How can management help you in your work?............
....
....
....

(Signed)....................
Superintendent of Inspection.

Survey of Management

111. This survey is useful as it will serve to rivet the thought of the company's officials upon essential features of shop management. Always keep in mind that the real *governing force* in your factory is your group of superintendents and foremen. It is *this* body of men who control operators, who usually state who shall or shall not be promoted or discharged, who usually estimate the rates of output off the different jobs and so set the wage rates—whose "say so" decides the *real shop* problems.

112. In fact, your production, your costs, your labor problems depend upon these men. They are, therefore, the vital factors in your business; they deserve all the encouragement, all the help, all the training that you can give them. They should always know fully what your policies on their shop problems are as they are the *real* interpreters of your policies to the workers.

113. Superintendents and foremen generally are a strong capable set of men that are willing to carry out the companies' policies. It is therefore important that the management lose no opportunity to gain the co-operation of these men—to give them every possible chance to learn more and become more efficient—to make them *real live forceful members* of the organization.

Management Survey

Date................

114. (1) (*a*) Total number of employees?...... Men...... Women...... American...... Foreign......

(*b*) Is source of supply of labor good......or bad?......

(*c*) What proportion of skilled labor do you require?........

(*d*) What is your average wage for skilled men........skilled women.........unskilled men.........unskilled women......... What is average rate in community for skilled machine men....... skilled women.......unskilled men.......unskilled women.......

115. (2) (*a*) Give name, age, length of service, salaries, estimate of ability, of the organization under *each superintendent* as follows: 1st, the superintendent; next, each of his assistants; next, the foremen under each assistant superintendent; next, the assistant foremen under the foremen, on typewritten form.

Training

116. (3) (*a*) Describe steps that company takes to encourage these men to improve their knowledge and ability................
....

(*b*) How often do you call them together?..............

(*c*) Do you have regular monthly foremen's meetings?........

(*d*) Do your men talk freely at such meetings, giving suggestions and complaints?..............

(*e*) ....
....

Co-operation

117. (4) (*a*) Do these men co-operate with one another and the company?............

(*b*) Or are they jealous, envious, working against one another?
....

(*c*) Why is this?...
....

(*d*) How can you get "team work" out of them as do many other companies?...
....

(*e*) Did you ever try getting them into committees to consider their own and the other fellow's problems?..............

Detecting the Efficient and Inefficient

118. (5) (*a*) How can you tell who of your foremen and workmen are the most efficient and inefficient?....................
....

(*b*) How can you settle who is worthy of promotion?........
....

(*c*) Who determines the question of promotion to assistant foreman........ to foreman........to assistant superintendent ....to superintendent..............

(*d*) Do you promote from the ranks or get outsiders for important positions?..............

Instruction in Policies

119. (6) (*a*) Have you ever instructed the superintendents and foremen about your policies in regard to handling labor.......... retaining and promoting the efficient..............ascertaining the inefficient for training or discharge..........controlling discharges ....non-employment of relatives.........eliminating favoritism..........

(*b*) What are these polices?...............................
....
....

Wage Rates

120. (7) (*a*) Are your wage rates set upon outputs from the jobs that are carefully determined by tests and the use of proper tables?.................

(*b*) Or are these outputs estimated by foremen?...........

(*c*) Are your outputs and wage rates satisfactory..........or, are they too high?...........

(*d*) Do your foremen cut or reduce rates when a workman earns an excessive amount?.............

(*e*) Or do you guarantee rates...................

(*f*) Or are the outputs so badly calculated that you do not dare to guarantee that rates will not be cut................

(*g*) Have you ever had a careful survey made to determine if you are getting all you should out of each machine and each operator?.................

(*h*) Are your wages paid higher or lower than wages paid for similar work in community?................................

Employment and Labor

121. (8) (*a*) Describe your employment system.............
(*b*) Does the factory recommend whom to employ?..........
(*c*) Have you any method of instructing or training the green operator?..........
(*d*) How long does it require on the average for a green operator to get up to a normal output?..........................
122. (9) (*a*) Is your labor satisfied?..........
(*b*) What causes for dissatisfaction have they?..............
....
....
(*c*) What are you going to do about it?...................
....
....

Costs

123. (10) (*a*) What use do you make of cost department?
....
....
(*b*) Do you check actual costs against selling price?..........
How often?......................
(*c*) Does the factory management get details of the operations upon which cost is highest and study them to cut them down?
....
(*d*) What efficiencies in cost department does survey show?
....
....
(*e*) What inefficiencies in cost department does survey show?
....
....
(*f*) What action will you take?..........................
....
....
....

Stores

124. (11) (*a*) How much abandoned stores does stores survey show?.................................
(*b*) How much over-ordered stores does stores survey show?
....

(*c*) How many delays does stores survey show?.............
....

(*d*) What efficiencies in stores department does stores survey show? ....
....

(*e*) What inefficiencies in stores department does stores survey show? ....
....
....

(*f*) What action will you take?..........................
....
....
....

Stock Tracing

125. (12) (*a*) Does your survey show that the assembling departments are delayed on account of slow delivery of finished parts?
....

(*b*) How serious is this?.................................
....

(*c*) Do your workmen loaf, indicating that materials are not promptly delivered to them?.....................

(*d*) Can your inventory be reduced, thus releasing working capital?.....................

(*e*) What efficiencies does survey show?.....................
....

(*f*) What inefficiencies does survey show?..................
....

(*g*) What action will you take?..........................
....
....

Purchasing

126. (13) (*a*) Are you getting materials at lowest prices?.....

(*b*) How do you know it?.............................
....

(*c*) Does purchasing department keep adequate quotation system? ....

(*d*) Does purchasing department overbuy......underbuy.....

(*e*) What efficiencies does purchasing survey show?..........
....
....

(*f*) What inefficiencies does purchasing survey show?........
....
....
....

(*g*) What action will you take?..........................
....
....
....

127. (14) Describe briefly in general report company's policy toward

(*a*) Sanitation;
(*b*) Cleanliness;
(*c*) Hospitals;
(*d*) Restaurants;
(*e*) Other items of similar character.

128. The following chapters in this book describe methods of management that have proven thoroughly effective in giving a real and vital control of affairs to the superintendent, manager and officials. The points brought out in these surveys together with many others have been covered effectively. All methods have gone through the fire of practical experience and have stripped from them all red tape and unnecessary costly systems. Recognizing the serious factor of over-head as a cost the methods are kept simple and can be operated by a small number of clerks.

129. As stated before, these surveys with these questions and replies will show the management where to strike first and hardest and will prove a guide for sensible effort TO INCREASE PRODUCTION AND CUT COSTS.

CHAPTER III

LEARNING ACTUAL PRODUCTION
LOCATING POINTS CAUSING TROUBLE
CONSIDERATION OF PRINCIPLE NUMBER ONE

Finding out what the Plant is *Actually* Producing—What the Products are *Actually* Costing—How each Department is being Operated. Production Reports—How to Get Them—How to Use Them—How to Locate Unerringly Every Point in your Shop where Trouble is Occurring.

1. Nothing in manufacturing procedure can equal the departmental surveys developed in Chapter II as real locaters of serious weaknesses. Each department with its strong points and its weak ones will be shown up as clearly as though its operations were thrown on a moving picture screen.

2. Usually there will be located a bewildering amount of defects—a study of these and their remedies will be very dry and tedious—and it will be hard work to overcome them. But, if you are to have a smooth running, low cost, high production shop, you have *got* to go through with the job and you have *got* to overcome *all* your troubles.

3. In order to get *quick* results, we must start first on finding out what the shop is *actually producing* in all of its departments. This is accomplished through production reports.

Importance of Accurate Production Reports

4. Never forget that accurate production reports are to the management as a man's fingers are to his hand. They give the management absolute *control*. And that control cannot be secured by any method other than "knowing what shop conditions and shop productions are."

5. When a concern is small, employing but few men, it is a simple matter for the owner to oversee his production and assure himself that he is getting it in proper quantities and of proper quality every hour.

6. He well knows that his whole success, and indeed fortune, is locked up in the results he gets from these workers and machines of his. He knows, too, that it takes eternal vigilance to get the necessary results.

7. When his business expands he must let go of such details and entrust them to others. Right at this point he loses his grasp of affairs and unless he is supplied with the same old information through production reports he falls and often is lost. The larger the business grows the more difficult the situation.

Production Reports Supply the Lost Links in the Chain

8. My point is that these production reports supply the owner and the superintendent with this lost information and that when they get it they can use it in exactly the same manner they used the knowledge of a "fall down" in shop production when the shop was a small one. Indeed, all the systems and methods described are planned to give the manager and superintendent of a large plant the data that he was formerly able to get from personal observation when the shop was small.

Production Reports as Locaters of Trouble

9. These reports not only tell the story of output but also locate unerringly the *exact point* in the shop where delays, breakdowns, tool troubles, everything that might cause a production shortage is occurring. The organization cannot get away from them, for they all know that *you* know every day just what is going on and that you can put your finger on any inefficiency, neglect or carelessness of theirs immediately it occurs. These methods keep the production organization "on its toes."

Big Difficulties Caused by Little Ones

10. I cannot make the assertion too strongly nor too positively that 90 per cent of the reasons for delayed and costly production arise from troubles that, taken by themselves, look insignificant, but when injected into the huge machine of production cause a break in the chain which is instantly felt all along the line. Therefore, keep this condition in mind as the following chapters outline the plans that will enable you to "locate your sticking points."

11. As examples: the purchasing department fails to properly follow up some purchase; the material doesn't arrive on time;

production is stopped; assembly ceases with losses and delays to customers. Or the stores department system is bad and as a result the materials are not ordered on time with the same result.

12. Or orders are needlessly duplicated with the result that thousands of dollars are tied up in dead stock.

13. Or the stock routing and tracing is so defective that the assembly departments are kept continually waiting for first one kind of stock and then another with a paralyzing effect on production.

14. Or tools on some jobs are too poorly designed to bring either accurate or quantity production owing to the usual lack of co-operation between the tool designing and factory with the result of poor work and delayed production.

Avoid Too Much Detail

15. Men often overlook the fact that a great mass of detail is needed to bring a shop from a state of inefficiency to one of efficiency, but that much of this can be abandoned *after* the desired condition is reached. For instance, at first daily reports of various kinds are essential, later weekly reports may often be substituted and a large saving made thereby. The essential parts of the main system must always be maintained, however, to keep the shop from slipping back to its old inefficient condition.

16. As an example, in one large shop that was far behind in its contracts, I found it necessary to get *every* day operation reports showing just what each individual turned out the day before. Through this we weeded out, selected and trained the operators until they were all brought up to a high state of efficiency. But, after the department had been brought up to the standards, such daily reports were no longer needed. We simply had their weekly outnut put upon their efficiency cards with a great saving in detail.

17. The same observations apply to "costing." So often a cost department will continue on day after day, month after month, setting down duplicate figures on piece-work operations that no one ever looked at, or, if he did, he could not use them as a basis for increasing efficiency.

The True Function of Reports

18. Every production report or cost report should *bear a message* of some kind and should tell the production manager *where*

there exist the danger points, the "high cost" points, the inefficient points, as well as the excellent ones.

Promptness

19. Prompt reports are absolutely essential. When daily reports are being used then the to-day's A.M. reports must show yesterday's results.

Build Upon Your Present Conditions

20. In introducing any systems do not attempt to rip out the old ones too quickly. Rather, study the situation and see if the newer desirable methods can be built up on your existing ones. In other words, "fit the system to shop conditions and not force the shop conditions to fit the systems."

21. The building up of new methods upon an old structure will be much easier because your organization, familiar with the old, will not oppose the changes so strenuously.

The Best Plan

22. The best plan is to call together the men to be affected by the new method and explain to them that you want a system of reports that will help *them* and also give you the required information. Lay before them the broad plan and ask them to come back the next day with their suggestions. You will be astonished to see how they grasp the subject and how simple and direct their suggested methods are.

23. After getting these you then map out your methods and call them together again, lay the whole plan before them in detail and get their further suggestions and criticisms. Be sure to incorporate in it every suggestion of theirs that you can, for when a man feels that a system is partly *his* he is going to *make* it work.

Choosing the Man to Head this Work

24. As I will show, the whole plan of reports is so simply built up from the job and time tickets that you can almost invariably find some bright ambitious young man in your organization to do this work effectively. Select some vigorous worker who knows what system means and who knows and is liked by the shop men, and give him high-grade helpers. The whole scheme

will work out much more quickly and easier by following this plan.

The Function of These Production Reports

25. Production reports will cover the following grounds:

(1) They provide accurate data as to actual production on all parts in all departments.

(2) They *immediately* show the exact location of every shortage in production, thus enabling the management to find out its *real* cause, whether it be foreman's incapacity, shortage of tools, lack of materials, poor machine tools, inefficient operators, defective parts, or any other cause, and then, to cure the trouble.

(3) They supply an unexampled method of tracing stock, of guiding the flow of parts through the shop so that delays are eliminated and any tie up of capital in non-moving material is prevented.

(4) They lead to the discovery of the inefficiently operated department, of poor workers, of any cause for inefficiency.

Production Reports

26. Production reports that serve to keep you, your superintendent and foremen in touch with actual conditions must cover all the production activities in a shop. They must show you upon each article you produce:

(*A*) Your total finished production and rejections from the final assembly.

(*B*) Your total production and scrap on *each job* in your assembly division and reports covering delays.

(*C*) Your total production and scrap in *each department* in your manufacturing division.

(*D*) In cases where conditions are very bad they should show your production and scrap *by each operator on each job*. This last may seem to involve much detail, but when conditions are unsatisfactory the trouble *has got* to be traced down through the shop to the individual operator. In fact, the securing of these data is simple.

From the Simple Workmen's Time Tickets Flow All Production and Cost Data

27. From the simple workmen's time tickets come all the production reports, cost data, efficiency records.

28. No matter what the system, elaborate or simple, these *little workmen's time tickets* form the foundations.

29. When the average observer beholds an up-to-date system with its seemingly elaborate reports on production, scrap and costs, its individual operators' records, etc., his first thought bears upon the supposedly tremendous cost of such methods.

30. Yet he is badly mistaken. All of these vital records are derived from these time tickets—the character of the data being determined by the way they are classified.

The Time Tickets Must Be Extended for Payroll

31. These are, of course, first extended so as to calculate the earnings of each operator for payroll purposes.

32. Each worker's ticket, which of course, shows "the part" and "the operation performed," will thus also show the "number of pieces finished," the "scrap," the "rate" and the "earnings."

33. It is perfectly evident, therefore, that by arranging these same tickets into different classifications, we will get data that are vital.

The Payroll

34. When we collect separately each worker's tickets and add up the amount earned we get the amount due him on the payroll.

The Individual Efficiency Records

35. When we collect each worker's tickets together and add together for each part the number of pieces "finished" and the "scrap," we get for each worker his total "number of parts finished" and "scrap" for his hours worked each week. Now! If we have, for each worker, a simple little card upon which we enter these weekly data we have the "individual efficiency record" showing the amount of work done and his scrap per hour each week.

36. By *comparing* this *actual performance* with the *established standard hourly output* (showing what *should* be attained) we at once establish his degree of efficiency. We know whether he or she is a good worker or a bad one.

Production Reports

37. When we come to consider methods of getting up production reports we find we have one condition when the work is

standard and the operations are repetitive, and another when the work is special and is performed on job numbers.

38. We will first consider the case where the work is standard.

Group Them According to Part and Operation

39. We then take all of the time tickets and gather them into groups *according to the part and the operation* performed, no attention being paid the workmen's names.

Simply Add Together the Important Items

40. On each group of tickets is added together the "parts completed," "parts scrapped," "parts accepted." (For cost purposes we also add together the time consumed and the total earning representing labor costs and parts accepted. This portion, however, will be treated fully in a later chapter. The production records will not contain the cost data as, outside of the superintendent, the shop should not have this information.)

We at Once Have the Production Reports

41. We at once have a record showing the *"actual production," "the scrappage,"* the *"net production"* on *each operation on every part.* These items form the *production records* which are so valuable to the factory manager and the superintendent.

Locating the Inefficient Spots

42. As any capable superintendent must know how much his factory *must produce on each operation* in order to meet his production schedules he can thus make a *distinct comparison* between what *has* been produced and what *must* be produced.

Any Shortage Will Show Up

43. Any shortage in output is thus immediately disclosed and its exact location is determined. *At once* the department foreman is called in for his explanation. It may be shortage of materials, bad tools, machine tools out of repairs, lack of workmen, threatened labor troubles, inefficient labor, excessive scrap; any one of the thousands of troubles that the shop superintendent usually struggles with.

44. The admirable feature of this plan is that *any* trouble is located *at once* while it is small, and when overcome the flow of needed parts begins at once.

An Example

45. These methods have worked very successfully in many large and small plants. In one were employed over 9000 operators on work requiring high skill. The total assemblage was 38,000 articles per day, each one averaging 67 parts. The total of operations on all parts was 427. Therefore, *for each 24 hours* there was 2,546,000 parts assembled involving 16,226,000 operations.

46. The machine tool equipment was limited owing to the difficulty of getting machinery. Therefore, every tool had to be worked to the limit of its capacity every hour, skilled repairmen tuning up the groups of machine tools after each shift.

47. Small tools and raw materials were difficult to get, therefore, every point in production and system had to be thoroughly organized in order to meet these intensified production conditions.

48. The program was carried through without a hitch mainly because these simple production reports enabled us to keep our fingers upon every shop condition, small or large. In fact, troubles were *overcome* and *settled before* they had a chance to become *real* troubles.

Stock Tracing Records

49. Naturally, such production records at once give the best method for locating all materials as they progress through the shop and, therefore, they are invaluable as *stock tracing records.*

50. As will be shown in a later chapter, the flow of materials and the order in which they are produced, will be under the sole control of the stock tracing department, which always knows what *must* be worked on from its records of parts on hand in finished stores and the assembly room needs. The foremen produce in accordance with instructions from this department. This work alone is of the greatest importance not only from the standpoint of keeping the assembly department well supplied with parts—absolutely stopping even the possibility of any assembling delay, but also supplying each factory department with an even flow of materials so that operators will be busy at all times.

51. Another important function is to keep to a minimum the amount of work that is in process of manufacturing and thus avoiding tying up the large sums of working capital that are usually

absorbed in quantities of materials lying around the shop and not moving.

52. These records also provide a valuable perpetual inventory of "work in process of manufacturing."

The Collection of Cost Data and Their Relation to Production Reports

53. Naturally all this collection of data for production reports keys into the work of the cost department. One may well ask why this work is not properly the work of the cost department. Under certain conditions the work may well be combined and the two departments be made one. The course to be pursued here is determined by the management's policy in regard to the cost department.

54. I always consider the cost department as being more of a productive tool than as an accounting problem. Fully 80% of the work of a cost department lies in its great value as a "cost reducer," through the constant investigation of high costs—the ever pressing attempts to lower them by every expedient—in other words, the using of its data to reduce costs to the lowest limit possible.

55. This can only be done when the cost department is under the control of the *factory management* and *not* the *accounting division.*

Avoid Too Much Detail

56. It is well to study each problem separately so that chief attention may be paid to those parts which are most important—the hardest to get through the shop—the ones that are usually delayed.

57. While a full record is usually advisable still examination may show a large number of parts of which there is always a plentiful supply and that are easy to get through the shop to finished parts stores, and of which nothing more than an occasional check is necessary.

The Building Up of Production Reports

58. As stated previously, from the workman's time ticket is built up every record—production, efficiency, costs. The form shown herein has been used successfully with a large number of companies. It must, however, be altered and adapted to meet conditions of any factory. The general principle will remain the same.

THE OPERATOR'S JOB AND TIME TICKET

63. In Figure 2 is shown the form for the operator's job and time ticket and in paragraphs 64 and 65 is given a description of the information that is recorded in its various columns. It should be fully realized that from this ticket is taken the essential information from which every record is built up.

NAT'L MFG. CO.

PART........ OPERATION ....

DATE........

BOX NUMBER	TOTAL NO. PARTS WORKED	SCRAP		TO BE RE-OPERATED	ACCEPTED	TIME			DAY WORK		BONUS		TOTAL EARNINGS	
		BM	BF			BEGUN	FINISHED	TOTAL	HOURLY RATE	TOTAL	BONUS RATE	TOTAL		

JOB BOSS.............. PAY ROLL CLERK ....

INSPECTOR.............. FOREMAN ....

DEPARTMENT.............. OPERATOR ....

FIGURE 2.—Form for Operator's Job and Time Ticket

60. This ticket probably differs in no essential feature from your present ticket and you can perhaps use them without change. A moment's study of this ticket makes it clear. It contains spaces for:

(*A*) Name or Number of part;
(*B*) Operation;
(*C*) Operator's Name or Number;
(*D*) Date work was performed;
(*E*) Inspector's name signifying his O. K.;
(*F*) Name of Department in which work was done;
(*G*) Pay Roll Repartment's O. K.;
(*H*) Foreman's O. K.;
(*I*) Name or check number of Operator;
(*J*) Name or check number of Job Boss.

61. Note that the four corners of this ticket contain part, operation, department and operator, for the reason that these tickets will often be separated according to these classifications and their location at the corners of the tickets makes each of them easy

to see when running through the tickets, by simply turning over the proper corner.

62. The center portion is very important:

Column 1—Gives the box or tray number of the container of parts. This identifies the work and prevents duplication of tickets by workmen as will be shown later.

Column 2—Shows the total number of parts worked. This datum will show on the production reports.

Columns 3 and 4—Shows the scrap. Column 3—BM signifying bad machining for which the operator gets no pay and in some cases gets a charge back for spoiled work. Column 4—B.F.—signifying bad foundry, which parts developed foundry defects upon machining. In many cases the operator will get paid for this work, the *foundry* getting the charge back. From this is made up the scrap reports, this being incorporated in the production reports, thus enabling the management to locate the departments and the operators responsible for excessive scrap.

These columns are filled in by the inspectors.

Column 5—Shows number of parts to be reoperated. Inspection quite often shows that while parts must be rejected because not within the tolerances, still they can be saved from scrappage by reoperations, the operators getting no pay for such parts until they reoperate them and bring them within the gages.

Column 6—Shows number of parts inspected and accepted and when added to Column 4—bad foundry—form the basis for pay.

Columns 7, 8, 9—Deal with time started and ended, and total time consumed. This is necessary for bonus calculations or daywork data.

Columns 10, 11, 12, 13—Deal with earnings.

Column 10 shows the rate (day work).
Column 11 shows day work earning.
Column 12 shows bonus rate.
Column 13 shows bonus earnings.
Column 14 shows total earnings.

In cases when piecework is used, you use only two columns—one showing rate and one showing earnings.

The signatures directly below shows the approval of the payroll clerk, the inspector, the foreman.

63. In cases where a job consumes a fairly long time (30 minutes or more) then separate tickets must be made out for each job. When jobs are finished in a shorter time (such work as "burring" for instance) then two or more items can be entered on one ticket, specially prepared for this purpose.

64. This job and time ticket differs in no essential points from thousands of others designed to fulfill a similar function. Probably your present ticket contains all this information.

This Ticket the Foundation of System

65. After extending these tickets for pay roll, then sort them out, for any desired period, according to *part* and *operation*—get your totals and you at once have the full production data for that period on any operation on any part, namely:

(*A*) The total number of parts worked;
(*B*) The scrap due to operator's carelessness;
(*C*) The scrap due to foundry defects;
(*D*) The number of parts reoperated;
(*E*) The total number of parts accepted by the inspectors;
(*F*) The total number paid for;
(*G*) The time consumed;
(*H*) The amount paid for labor.

66. First: These (properly filled out) will give you "production data by operations" on each part.

Second: Again, *sort them out by departments,* make your calculations and you get an "accurate record of departmental output."

Third: Sort them out *according to operators* and you get an accurate record of each operator's output, scrap, earnings, and thus form an "accurate record of their individual efficiency."

The First Steps in the System

67. First Step: Run through all the tickets and first separate and collect them according to "part" and also according to "operation." You thus have the tickets showing on each operation the total output, scrap, accepted parts, time consumed, and earnings on the operation for the day previous.

68. SECOND STEP: By adding together the amounts shown in the different columns on the tickets you immediately and simply have for each operation upon each part of the day previous:

(*A*) The total worked;
(*B*) The bad machining scrap;
(*C*) The bad foundry scrap;
(*D*) The total of parts accepted by inspection;
(*E*) The total reoperations;
(*F*) The total paid for;
(*G*) The total earnings—whether this be piece work, day work, or day work and bonus or premium.

69. THIRD STEP: This information should then be put upon the form shown in Figure 3. A separate sheet should be made out for each of the main parts. For the subsidiary parts one sheet may be ruled up so as to contain a large number and thus reduce to a minimum the number of sheets to be examined.

THE KEYSTONE OF THE ARCH OF PRODUCTION

70. This report forms the keystone of the arch of production reports and deserves especial study.

71. The upper portion gives *name of products, name of part, date of report, date of output.*

Column 1—Gives the names or numbers of the operations in sequence.

Column 2—Shows the department in which the work was done.

THE IMPORTANT QUESTION OF WHAT SHOULD BE PRODUCED

Column 3—Is of particular importance as it shows the "output required" on each particular operation, using the machine tools you have.

THE REAL FUNCTION OF THIS COLUMN

The real function of this column will be developed after we have gone thoroughly into methods to determine the "actual standard hourly outputs" that should be secured off the machine tools or operators upon each operation. When we know what *should* be produced off of each machine tool or each group of tools or operations each working up to efficiency, we

PRODUCTION REPORT

DAILY COMPARATIVE OUTPUT REPORT FOR WEEK ENDING Sept.................

NAME OF PART .Base Forging HB .....   PRODUCT .FUZE #49.......   NUMBER REQUIRED DAILY .25,000.......

OPERATION	DEPT.	OUTPUT REQUIRED	MONDAY – SEPT. TOTAL PRODUCED	SCRAP BM	SCRAP BF	NET ACCEPTED	ON HAND
FORGING	HYDR	30,000	35,400	400	550	34,550	83,661
INSPECT							
1ST HAND SCREW	MACH.	29,600	32,441	610	720	31,111	46,865
HAND TAP	TAP	29,300	30,400	360		30,040	37,841
INSPECT							
2ND HAND SCREW	MACH	28,850	30,060	400	100	29,560	29,463
INSPECT							
THREAD MILL	MILL.	28,300	29,040	204		28,836	34,654
3RD HAND SCREW	MACH.	27,600	29,684	621		29,063	33,964
MILL	MILL.	27,000	27,800	256		27,544	30,456
INSPECT							
MILL	MILL	26,700	27,100	329		26,771	34,883
KNURL	MACH.	26,200	26,040	276		25,764	29,461
INSPECT							
1ST DRILL		25,800	27,600	401		27,199	31,382
2ND "		25,400	27,060	215		26,845	28,410
3RD "		25,000	27,010	315		26,695	27,420
FINAL INSPECT TO FIN. STORES		25,000	26,453				

TUESDAY – SEPT.						WEDNESDAY – SEPT.						THURSDAY – SEPT.						FRIDAY – SEPT.						SATURDAY – SEPT.					
TOTAL PRODUCED	SCRAP BM	SCRAP BF	NET ACCEPTED	ON HAND		TOTAL PRODUCED	SCRAP BM	SCRAP BF	NET ACCEPTED	ON HAND		TOTAL PRODUCED	SCRAP BM	SCRAP BF	NET ACCEPTED	ON HAND		TOTAL PRODUCED	SCRAP BM	SCRAP BF	NET ACCEPTED	ON HAND		TOTAL PRODUCED	SCRAP BM	SCRAP BF	NET ACCEPTED	ON HAND	

ON HAND IN FINISHED PARTS STORES 49,657

FIGURE 3.—Form for Production Report; Refer to Paragraph 74 on Page 87

are then in a position to make such a use of this column as will force the shop up to its highest standard of output with absolute certainty.

The Substitute Function

But we are not yet ready for that most important work known as the determination of "standard hourly outputs."

We therefore must temporarily substitute our knowledge of what we must *produce* on each operation to get the *required* output, being careful to make the proper allowances for expected scrap.

The data should be secured in conferences with the superintendent and foremen. It is a simple matter to get them, for in each case they are determined by the number of finished articles you wish to turn out each day multiplied by the number of each part that go to make up our finished article plus a proper allowance for scrap.

The Difference

It is evident that there may be a great difference between what study shows *should* be the output and what you determine you must have to get your output. We shall, however, lead up to the proper plan gradually.

Columns 4, 5, 6, 7, 8—Are the output columns.

Column 4—Gives the total worked.

The Important Question of Scrap

Columns 5 and 6 show scrap.—These columns are very important. Every operation should have apportioned to it an allowable percentage of scrap and any excess above this allowable should be gone after remorselessly. Scrap means the heaviest kind of losses for you lose the part, the wages paid on previous operations, and the loss of

time incurred in bringing through substitute parts.

Prompt and *full examination* of the causes of scrap are very important. They may be due to bad tooling or worn gages, or poorly trained or careless operators, or too hurried work, or poor supervision, or defective materials.

Column 7—Shows the net output.

Number of Parts on Hand

Column 8—Shows the number of parts on hand at and ahead of each operation. At first this may seem a difficult bit of data to obtain, but experience shows that once a careful inventory is taken it is simple to keep it up.

It is important to keep this up, as not only does it provide an excellent inventory of work in progress, but it also shows clearly just when materials pile up in front of jobs and shows clearly where the regular procession of parts through the factory is being held up. This always indicates a condition that needs attention.

Stock Tracing

These columns are especially needed for efficient stock tracing, as through these, the parts that are badly needed by the assembly departments can be quickly located for further "RUSH" operations. This important work will be fully described later.

At the bottom of this sheet will be shown the number of parts in Finished Stores. This will show clearly what work should be rushed and what need not be worked upon.

Comparative Data

72. The data for the entire week, day by day, will be found very useful as the manager and superintendent can see, at a glance, how each part is progressing or falling behind day by day.

Use to Make of This Highly Important Report

73. This report now gives you what you most need and what is partly covered in the first "Principle of Modern Production"; namely; it tells you what you *are* producing.

74. Now, Column 3—entitled "Output required for 9 hours"—tells you what *should* be produced in order to get the required output as per page 83 (although this by no means indicates as yet the *full output* of your machine tool and operators when working up to *full capacity*).

You Immediately Locate Your Weak Spots

75. You have now this highly desirable comparison between the output you must get and the output you *are* getting. A study of this comparison will instantly reveal the points where the factory is strong and where it is weak.

The Superintendent Has Control

76. The moment the superintendent has this report in his hand he has *actual control* of his shops. He *knows* that yesterday Bill Jones' milling department milled up only 51 crank cases when the output demanded 240; that Bickford's hand screw machine job fell down to only 30% of its capacity on most important parts; that here was a good showing and there a bad one.

77. He immediately calls in the foremen only to find that Jones has run into a bad lot of milling cutters; that all the steel on hand is no good and there will have to be strenuous work done to get new steel in in time to meet conditions. He finds that Bickford's department fell down because the stores department ran out of forgings with none in sight.

78. These are *not* fanciful examples. They used to occur thousands of times to me when I was a superintendent. Many a superintendent is driven almost frantic by such conditions that occur over and over again and yet that he does not know about until they become serious. After I started this method my big worries disappeared for I *know the facts* as soon as any difficulty "stuck its head over the horizon of trouble" and I could then get after them and conquer them before they became serious.

It Is Not Always the Production Department's Fault

79. We must never forget, too, that in most factories the real

hidden causes for serious production delays lie at the doors of departments other than the Production. The stores, the purchasing, tool room, tool supply, designing—every fall down or delay there is reflected in production. Such facts seldom come to light for the superintendent so often finds his justifiable complaints concerning them not attended to properly—they only serving to get him in bad with the "powers that be"—that finally he makes up his mind that he will get along as best he can without kicking, only emitting a wail once in a while that is usually misunderstood.

How the Superintendent Handles the Reports

80. When he gets his morning's report and notes all conditions, he then calls in for a brief conference all the foremen (perhaps in groups) who show a breakdown in production. Showing them this report he demands their explanations.

81. The foremen, confronted by this record which cannot be dodged, then begin to *tell* the facts—*uncover* the causes. Of course, a number of them, when faced with the record, will attempt to "slide"—to place the responsibility on some one else when it *should* be theirs. But when confronted with the man whom they wrongfully blame they soon get over this habit.

82. As a matter of fact, a good active stock tracing department with members circulating through the shop, pushing the work everlastingly, have probably already learned the true reasons for delays and have advised the superintendent fully.

83. Should the trouble be caused by the tool room, then this foreman is called in and explanation demanded. Any troubles *he* may have are remedied quickly. Should it be shortage of materials, then in comes Mr. Stores Keeper for his explanation. Or it may be the purchasing department, the stock tracing, the repair men—any one of a dozen departments.

Whatever It Is, It Is Remedied

84. But *whoever* is responsible and *whatever* the trouble, it is remedied *in a hurry*.

Effect on the Foremen

85. The effect on the organization is almost magical. As soon as they find that "the old man knows" and that there is *no escape* for them, the manner in which they "get up on their toes" is

amusing. They soon learn that it pays to get together and help one another out.

When we couple these reports with the other production reports for assembling department and non-production department we have a complete comprehensive system that reaches to the innermost regions of the shop and, best of all, does it very simply and inexpensively.

An Actual Example

86. In our shops under my control I required the superintendent to report in full detail on all delays and the reasons therefore, the difficulties, of course, being overcome daily. I am reproducing some letters as they show clearly the surprising reasons for delays and the ramifications that an investigation leads you into, and every point had to be made right. Here is the correspondence with one of them.

87. THE NATIONAL MANUFACTURING CO.

Nov. 12, 1918.

Mr. Carpenter,
Manager.
Dear Sir:

I give you below the reasons for shortages.

You will note in this list a number of items for which my organization is responsible and which I assure you is having the earnest attention of myself and the Foremen, and will be quickly corrected.

On the other hand the delay on the larger numbers of items is due to conditions in other departments not under my control. They have already been reported but I will appreciate your co-operation in getting these matters straightened out.

Part.	Operation.	Amount Required per week.	Actual Output last week.	Reason for Shortage.
H- 3	Routing	110,000	86,000	Ran into poor lot of cutters causing delay to operator in changing same — reported this to Stores Department on Nov. 10. Situation serious.
H- 5	Milling	220,000	185,000	Design of this fixture is not correct for such class work. Tool Designing Dept. will not change this as they claim it is fault of Manufacturing Division. I can prove they

				are wrong. Had to work overtime to keep up.
H-14	Screw Mach.	240,000	196,000	Foreman of Screw Machine Job off on vacation and I did not watch his assistant in charge closely enough. Will correct at once.
H-20	Screw Mach.	138,000	101,000	Same trouble as above and also ran into some bad stock containing hard spots and cracks causing delays and breaking of tools. Have reported this to Stores and Purchasing Department.
	Milling	130,000	106,000	Our fault as fixture became worn and operator failed to notify foreman. Inspection scrapped parts and careless operator discharged. This fixture can be improved upon as it is slow and is liable to cause scrap at any time.
H-39	Milling	220,000	171,000	Shortage due to new operators on job. Have sent two back to Training Department for further training and will get better results this week, as foremen are helping the new operators especially.
	Drill and Co-bore	220,000	180,000	This job is continuously giving trouble because of shortage of ccunter-bores. We never seem to be able to get enough from the tool crib. It's up to the Tool Supply to get more in Stock.
	Tap	220,000	165,000	Shortage due to shortage on previous jobs.
H-40	Hand Screw Mach.	120,000	45,000	Due to shortage of material. I am always having trouble here for some department, either Stores or Purchasing, does not order enough at one

				time. This is serious as it is a job with a lot of operations and it is always on the Rush List. Get me plenty of these forgings and I'll get them out.
H-44	Hand Screw Mach.	135,000	80,000	Another job always needing forgings. I need four more No. 2 W. & S. Hand Screw Machines as Inspection is holding work closer and I must have these machines to get the output. I sent in requisition for them over three weeks ago and don't know what has become of it although I am told it was turned down. I can't get out these parts without the forgings and machines.

Assuring you that I will appreciate your help in these matters and that I will overcome the things that are my fault, I remain,

Very truly yours,

James Brown,

Superintendent.

88. The manager acknowledged the superintendent's report and assured him that it will have prompt attention.

89. The manager immediately took up these details and found that on:

H- 3 The cutters were bad—that all cutters in stores were likewise bad—that the cutters coming in were of same poor quality, due to the manufacturer of cutters using a poor grade of material and inspection not catching them, and that while stores had the report on November 10th that they did not send the information to purchasing department until November 13th and the purchasing department had not yet notified the manufacturer, nor had they made arrangements to charge back thousands of dollars worth of defective cutters to the manufacturer. And all this time the output was dropping down.

H- 5 Badly designed tool. This tool was not properly designed. Two slight changes, suggested by the fore-

men, corrected the difficulty and stopped the overtime work.

H-14 Superintendent took care of this.

H-20 Investigation showed that purchasing department had not taken up promptly with mills the matter of defective brass rod and, therefore, the mills were still shipping in bad materials. As it was difficult to get any kind of brass rod at the time, this gave rise to a difficult situation calling for the personal attention of the company's officials.

H-39 Milling—The foreman soon straightened this job out. Drill and counter-bores. After considerable checking it was discovered that the tool supply had failed to increase their ordering limits when this job increased its output and, therefore, were always short.

H-40 Hand screw machine—Shortage due to lack of forgings. This is especially interesting because it happens so often in a shop. In this case it developed that the purchasing department had changed the source of supply due to lower prices but had failed to take in account the length of time necessary for the new company to build up its production and had not continued with the old source of supply long enough. This was a very serious matter and did result in a 12% lowering of output for 10 days.

H-44 Hand screw machine—This shortage was due to too low an ordering limit in the stock room. A close investigation of the job showed that only two additional machines were needed but that these were necessary.

90. These were actual examples taken "from life" in a shop with 4000 employees working under high pressure. Nothing could better illustrate the point that the big shop troubles arise only because of seemingly little ones hidden way down amongst the shop methods and systems where only the foremen or sub-foremen know of them. Of course, theoretically, they *ought* not to exist. Some men insist that there is no excuse for them, but as long as these matters have to be handled by human beings just so long will they creep in and spoil the best of production plans. Every sensible production man *knows* it.

91. After the manager has straightened everything out he wrote the following letter to the superintendent.

98. NATIONAL MANUFACTURING COMPANY

DETROIT, MICHIGAN

Nov. 13, 1918.

MR. JAMES BROWN,
Superintendent.
MY DEAR SIR:

I am pleased to note that already the production reports reflect favorably the results of your efforts.

In regards to the other matters you brought up.

H-3. The manufacturer of routing cutters has corrected the trouble and new cutters of proper material will be here Nov. 25th. In the meantime, please overcome this handicap by overtime work or any means that may suggest themselves to you.

H-5. As you know the redesigned tool for H-5 will be completed on Nov. 23rd. Please work overtime on this job until the shortage is overcome.

H-20. The matter of defective brass rod (H-20) has been taken up with the mills. This situation is serious as we cannot get any good rod in until Nov. 31st. The Inspection Department is going over the rod in Stores again in order to sort out the best but even then we shall have to depend upon your foremen on this job to sort out quickly the bad rod as these troubles show up mainly after you have started machining. Put a night gang on this job. The scrap will be charged back to the mills.

H-39. Counter-bores—This shortage is now overcome. Please advise if you run into it again.

H-40 and *H-44.* We are rushing in new supplies of these forgings. Please be prepared to run a night shift on this job by Nov. 27th, the date they will arrive. The entire matter is now taken care of.

We have ordered "RUSH" the No. 2 Warner & Swasey screw machines you needed.

If there is anything else needed, please advise.

Yours truly,
C. U. CARPENTER,
Manager.

92. Nothing could more clearly illustrate the intertwining and interdependence of the many departments in a big business. They are in absolute dependence one on the other—a lack of efficiency in one department is certain to be felt in the other sooner or later.

93. Methods of this kind mean CONTROL. Just as the general knows the position of his troops, their number, their experience and training, their ability on attack and defense, he knows what division to advance and what to hold back. Any delinquency is instantly caught—any fine act, recognized and rewarded. In short, he HAS CONTROL.

94. So it must be in a shop. There must be "CONTROL" over every phase of it. The shop must *feel* it. They must know that

their delinquencies will be caught (perhaps for punishment), their good acts recognized, perhaps rewarded.

Principle Number One

95. This, then illustrates the working out of principle number one, which is:

"Finding out what the plant is *actually* producing. What the products are *actually* costing. How each department is being operated. How to get production reports, how to use them. How to locate unerringly every point in your shop where trouble is occurring."

CARRYING THESE PRODUCTION REPORTS DOWN TO THE DEPARTMENTS

Foremen's Production Reports

96. Each foreman should receive a report of his daily output, preferably from his superintendents, provided they can be made out promptly. Each foreman will then know the exact status of his department. He also knows that the *superintendent knows.* This report of the foreman should show anyone immediately where the output has been below the required output in his department. (See Figure 4.)

Production Reports as Stock Tracing Sheets

97. Modern development has shown that in all factory management methods, nothing exceeds in importance the proper regulating of the flow of parts through the shop to finished stores.

98. The amounts of money lost through the average assembling room being delayed on account of shortage of parts and the workmen standing around waiting for the arrival of delayed materials is nothing short of astounding.

99. Again, too, when materials are not properly recorded and traced there is always a great useless mass of it tied up in the shop itself, stacked around in this or that corner, lying around until dusty, and every moment absorbing and tying up working capital that ought to be in a bank or in the business in a more useful form.

100. As a matter of fact, the experienced production man, when taking hold of a run-down concern suffering for lack of capital, will always begin on stores and "work in process," confident that there will be found thousands upon thousands of dollars that can be released.

101. Production reports as stock tracing records are "worth their weight in gold."

Operation as Stock Tracing Sheet.—First Step

102. The stock tracing department first learns every evening from the records of parts in finished parts stores the exact conditions of all parts there. Those that are very low and that must be RUSHED and those that are *getting* low and which must be concentrated upon by the foremen to prevent them from getting dangerous.

FOREMAN'S PRODUCTION REPORT

DATE......................

MR. .... FOREMAN DEPARTMENT..............................

YOUR OUTPUT YESTERDAY WAS AS NOTED BELOW ~ PLEASE REPORT IMMEDIATELY CAUSE FOR ALL FAILURES TO MAINTAIN STANDARD SCHEDULED OUTPUT~YOU ARE HELD STRICTLY ACCOUNTABLE FOR STANDARD OUTPUTS WHICH MUST BE MAINTAINED.

PARTS OPERATED ON	OPERATION	HOURS WORKED ON JOB	ACTUAL PRODUCTION	YOU SHOULD HAVE PRODUCED	REPORT IMMEDIATELY TO SUPERINTENDENT REASON FOR FAILURE

FIGURE 4.—Form for Foreman's Production Report

Second Step

103. They, as soon as the production reports are ready, look up the Production Reports on the parts needing attention. By running up the columns from the bottom they easily locate the department holding those lots of these parts that are nearest completion and list these up.

Third Step

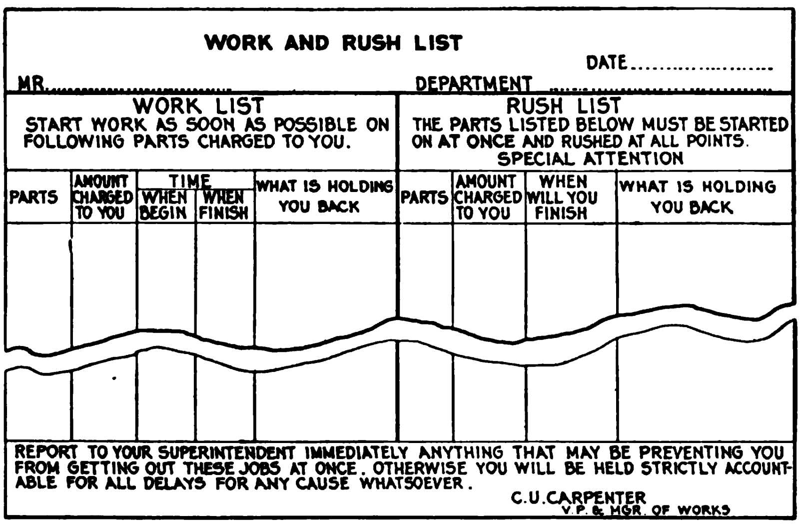
104. They at once notify in writing the different foremen who are responsible just what stock must be "RUSH" (which must always have the "right of way"), and also those parts which should be worked upon.

Fourth Step

105. The foremen, having such guiding lists, get the work out accordingly. If anything in the way of tools being repaired, breakdowns, shortage of help, etc., holds them back, they go to the superintendent for help, also notifying the stock tracing department.

106. It is obvious that with this plan delays will disappear as in a short time the RUSH items will disappear.

115. This important work will be explained fully later. But



WORK AND RUSH LIST

DATE..................

MR.......................... DEPARTMENT ....

WORK LIST START WORK AS SOON AS POSSIBLE ON FOLLOWING PARTS CHARGED TO YOU.					RUSH LIST THE PARTS LISTED BELOW MUST BE STARTED ON AT ONCE AND RUSHED AT ALL POINTS. SPECIAL ATTENTION			
PARTS	AMOUNT CHARGED TO YOU	TIME WHEN BEGIN	TIME WHEN FINISH	WHAT IS HOLDING YOU BACK	PARTS	AMOUNT CHARGED TO YOU	WHEN WILL YOU FINISH	WHAT IS HOLDING YOU BACK

REPORT TO YOUR SUPERINTENDENT IMMEDIATELY ANYTHING THAT MAY BE PREVENTING YOU FROM GETTING OUT THESE JOBS AT ONCE. OTHERWISE YOU WILL BE HELD STRICTLY ACCOUNTABLE FOR ALL DELAYS FOR ANY CAUSE WHATSOEVER.

C. U. CARPENTER
V. P. & MGR. OF WORKS

Figure 5.—Form for Work and Rush List Referred to Paragraph 104

this simple system worked perfectly in the shop already referred to, completing 38,000 articles involving the *daily completion* of 2,546,000 parts involving 16,226,000 operations, as well as in many much smaller.

The Superintendent's Job

107. The superintendent must watch these reports like a hawk. The *moment* any shortage in his required output appears, down he must go *after the job,* reports in hand. It is *much* more effective to go down on the job and confer with the foreman *there* than to call him to the office. If it develops that some other department such as tool room or maintenance or engineering is to blame, then call *that* foreman down *on the job* also. The super-

intendent will also watch the reports for any large accumulation of parts at any one point for this, too, usually indicates "something wrong."

108. By using such homely common-sense tactics the superintendent gets *close* to his foremen and the work and, too, they then cannot dodge responsibility. Such questions will be gone into fully later, but the illustration of this simple "right to the point" working of this plan will be made here.

THE ASSEMBLING DEPARTMENT

Assembly Production Reports

109. In the average shop the assembling department usually has so many "alibis" for their own production failures in the shape of complaints of "shortages of parts" or "defective parts passing inspection," that its own defects are not often disclosed but yet, in the assembling departments is where the costs mount up to alarming figures due to various conditions which cannot always be easily observed. The assembling division is particularly susceptible to delays on account of non-receipts of materials which may be due either to shortage of parts or to poor quality of workmanship which has caused excessive scrappage by inspection.

110. Unless he has been through such a situation the manager cannot realize the great differences in final production between a case where there are continuous delays and shortages of materials in the assembling department and the ones where the flow of materials is steady and even. After an assembling department experiences a number of delays and they find that the troubles are not being corrected, they seem to try to adapt themselves to this condition and do the best they can without further protest. We must not forget that one factory man does not like to complain against another and often the superintendent of assembling will accept a condition of shortage of materials as a regular occurrence and hence, will not complain as he should. It is safe to say that in the final assembly department where the usual conditions of delays due to shortages of materials occur, it is possible to increase production 50% with the same operatives provided the flow of material is arranged so that there are no interruptions but comes *in a steady flow.*

111. It is therefore the function of the assembly production reports to disclose the conditions which cause all delays. These

delays may be the fault of the management of the assembly department, or the fault may lie with the machining division, but wherever it is, it will be exposed for immediate correction.

112. It is difficult to give any forms that are, in general, illustrative of the conditions in the assembling department as these conditions in different businesses vary much more than in the machining of parts, but the forms shown will serve as a guide for the manufacturer in drawing up his own. They are simple and and can be amplified to meet anyone's needs.

Method of Assembling

113. The assembling of a product may take the form of a group of men assembling the total product, or of dividing the

DAILY SUB-ASSEMBLY REPORT

DATE ....

PRODUCT .... SUB-ASSEMBLY ....

REQUIRED OUTPUT	ACTUAL OUTPUT	REJECTION	WHY	NET OUTPUT	WHAT ARE REASONS FOR FAILURE TO MAINTAIN OUTPUT
				Signed	....

Figure 6.—Form for Daily Sub-Assembly Report; Refer to Paragraph 114

assemblage work up into special sub-assemblies which are assembled by separate groups and later brought together by assembly into the final product, or progressive assemblage may be so arranged to have a sequence of assembling operations follow one another so that as the work proceeds down the line one operation after another is added to it until the production of the finished article is the result. This latter method of progressive assembly will be dealt with in a separate chapter owing to its importance. The writer realizes that it is quite impossible for the average concern to turn upside down its present systems of assembly to meet any new suggested conditions, and therefore, we must assume that the old methods of assembly would continue until newer and more eco-

nomical methods can be proven to be an improvement and can be gradually introduced.

114. We therefore build up for the Assembly Department, reports similar in character to those for the Machining Division, the idea being to always *locate in full any shortages* and *any delays.* Each sub-assembly must make out Daily Reports.

Discussion of Report

115. Column 1 shows the total assemblage required off of this particular sub-assemblage in order to meet the production requirements.

Column 2 shows the actual sub-assemblies produced.

Column 3 shows the amount rejected by inspection.

Column 4 contains a brief explanation of why it was rejected.

Column 5 gives the net output.

Column 6 shows reasons for any failure to meet the required output.

Bring Out the Facts

116. This column No. 6 is particularly important as you will find in actual practice that it will be filled with explanations of shortages of parts from finished stores, breakdown of tools and machinery, explanation of badly designed tools, requirements in the way of new machinery, and many other valuable explanations. This column No. 6 is the important one of the entire report and must receive the *immediate attention* of the superintendents and manager who is supposed to trace down each and every item listed up to ascertain the cause for failure to meet the required output. You will often find that while foremen will hesitate to verbally blame another department for their delays, that when they are required to put such explanations on *paper,* the facts will then come out.

117. You will note at the bottom of this report we have the following notation: "In case of shortage of any character, subforemen must report same immediately or they will be held responsible for conditions."

Special Trouble Men

118. At times when starting out a report of this character I often found that there were so many legitimate complaints, that it was necessary to put special trouble men on the job, who, working under the superintendents, would pursue these bad conditions down to the *real* causes for them and so report in order that proper and *quick* action might be taken.

129. This report is so important that the superintendent should get it daily. In some cases where especially high pressure had to be brought and where much trouble was being experienced, these reports came in every two hours, but this is usually unnecessary.

Final Assemblage Reports

119. The report, daily, is for covering the Final Assembly. (See Figure 7.)

FINAL ASSEMBLY OUTPUT DATE..................

PRODUCT ....

LIST OF SUB-ASSEMBLIES	REQUIRED OUTPUT	ACTUAL OUTPUT	REJECTED	WHY	NET OUTPUT	REASONS FOR FAILURE TO MAINTAIN OUTPUT
#1						
#2						
#3						
#4						
FINAL						
						Signed..................

Figure 7.—Form for Recording the Output at Final Assembly, Refer to Paragraph 119 and 120

Discussion of Report

120. Column 1 shows the output required.
Column 2 shows the number of articles actually finished.
Column 3 shows the number of finished parts rejected by inspection.
Column 4 provides for a brief explanation of the reasons for this rejection.

Column 5 shows the actual output for the day.

Column 6 gives the reasons for any shortage in output.

121. All of these columns are clear, but column 6 deserves special attention. The reason for a serious shortage in final output might be the lack of sub-assemblies from one or more sub-assembly divisions, which condition must be immediately investigated. It can thus be ascertained at once whether or not the sub-assemblies have properly reported the reasons for *their* failures to produce.

Factory Manager's Report

122. Inasmuch as these reports, valuable as they are, may be too many in number for the factory manager to look them over, is wise to have a report made up similar to Figure 8.

ASSEMBLY REPORT FOR WEEK ENDING ....

PRODUCT ....

LIST OF SUB-ASSEMBLIES	REQUIRED OUTPUT	MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY		
		ACTUAL OUTPUT	REJECTS	NET OUTPUT	ACTUAL OUTPUT	REJECTS	NET OUTPUT	ACTUAL OUTPUT	REJECTS	NET OUTPUT	ACTUAL OUTPUT	REJECTS	NET OUTPUT	ACTUAL OUTPUT	REJECTS	NET OUTPUT	ACTUAL OUTPUT	REJECTS	NET OUTPUT
SA No. 1																			
SA 2																			
SA 3																			
SA 4																			
SA 14																			
SA 15																			
FINAL ASSEMBLY																			

FIGURE 8.—Form for Weekly Assembly Report Refer to Paragraph 122

Discussion of Report

123. It will be seen that this report is similar in all respects to the preceding report (Figure 3, page 84) with the exception that the first column is set aside for a list of the sub-assemblies and the report itself should be long enough to include all of these sub-assemblies. Then when the manager gets this report it shows at a glance the conditions of each sub-assembly and, in addition thereto, the final assembly for the day previous.

124. It is usually such a simple matter to get a list of the outputs of the sub-assemblies and final assembly that it is not always necessary to have such reports come from the systems department but they can be made out in the assembly room. In case the latter procedure is followed out care will have to be used to see that they are made out properly and correctly, and it is always well to check them up once a week with the data from the systems department.

The Job Boss and His Reports

125. In most up-to-date shops the management, knowing that the foremen or assistant-foremen *cannot* oversee 80 to 120 operators properly, divide these operators into small groups, putting over each group a job boss. This job boss works at the machine or bench as do the rest but he is paid an additional amount for overseeing the people in his group.

126. Of course, in some factories, such a man may not work at the machine but may give his time to supervision, but often this cannot be done as it increases the over-head too much.

127. These men have no right to discharge operators, but can recommend this to the foreman who may or may not act in accordance with the recommendations after he has investigated.

128. They are, however, held strictly responsible for the amount and quality of output of their operators.

He is Important

129. It's really hard to exaggerate the importance of the JOB

JOB BOSS OUTPUT RECORD week ending.......

PART.................. OPERATION.................. STD. HRLY. OUTPUT....

MR. ________________ JOB BOSS ________

THE OUTPUT RECORD OF YOUR....OPERATORS FOR THE PAST WEEK SHOWED AN AVERAGE OF......PER HOUR AS COMPARED WITH OUR STANDARD OF......PER HOUR.
YOUR SCRAP RECORD SHOWED.......PER CENT.
ALL SHORTAGES IN PRODUCTION OR EXCESSIVE SCRAP ARE TO BE EXPLAINED BY YOU.

FOREMAN.................. SUPERINTENDENT..........

Figure 9.—Form for Job Boss Weekly Output Record, Refer to Paragraph 131

BOSS. There he is, buried right in the detail of his pob—he *knows* his every tool and machine—he *knows* his operators, their skill or lack of it, their brightness or stupidity. He *knows* HIS JOB as no one else can *possibly* know it. He has a greater supply of suggestions on how to improve HIS JOB than anyone can even imagine; only they are seldom wormed out of him.

How to Develop Him

130. This will be treated in another chapter. But here I can recommend the use of your Production Reports. Going back to the workman's time ticket you will note that I recommended that a name of the operator's job boss be placed thereon.

The Job Boss's Production Report

131. Sort out the tickets by name of job bosses, and then make out a report conforming to the form shown below. Either have a form or write a letter. A specimen form is given in Figure 9.

132. This form is self-explanatory. The job boss sees facing him a record he cannot dodge. It shows what his little group *has done* accompanied with what it *ought* to do. It also shows any excessive scrap record against him. The lower portion of the form is left for comments by the superintendent who can comment on bad showings and praise for good showings.

133. When a job-boss' record shows up very badly, the superintendent can refer to the operators' record and locate the inefficient operators and ascertain the causes. They may need further training or may prove unfit. Whatever the cause, it must be overcome.

134. It is certain that the job boss himself will *speedily* take care of any inefficiency developing when he knows that this record faces him.

135. Such records serve as an excellent guide to the efficiency of these men, especially when a promotion is being considered.

Individual Operators Reports

136. At times, when the pushing up of the production of a shop is very important, we may well go further and get out a weekly record showing under the job bosses' names the *name* of each of his operators with their output and scrap record. Such detail may often prove too elaborate for use on all parts. Therefore, select carefully the most important parts which are continuously giving trouble and make out these detailed reports on these alone.

137. Then make reports (say, once a week) for each job boss. showing first his name second, the name and *output* and scrap of

each operator under him. Show the standard output in comparison with the actual output. See form of Figure 10.

138. This form is used where the operators work continuously on the same operations. The form itself must be varied to suit conditions.

OPERATORS RECORD for week ending ....

PART.................OPERATION ....STANDARD HRLY. OUTPUT........

OPERATORS	OUTPUT	SCRAP		RE-OPERATE	NET ACCEPTED	AVERAGE PER HOUR	REMARKS
		BM	BF				

JOB BOSS .... FOREMAN ....

FIGURE 10.—Form for Weekly Operator's Record, See Paragraph 137

He Finds That the Manager Knows

139. When Mr. Job Boss finds that the factory manager really *knows* how he is handling his group of operators he surely "gets moving at a lively gait." I always bulk my job bosses' reports on one large sheet so that a comparison between the work of ten or twelve groups of operators and their job bosses show on one sheet. I then mark the work of the good job setter with some congratulating comments, and make some rather stringent comments on the record of the ones showing poorly. This I send to one of the superintendents who personally takes this report to the foremen and they too pay a visit to the job bosses.

140. The effect has always been immediate. The good job bosses swell up with pride because the "big boss" has praised their work. The poor ones are mortified because their "fall down" was noted. Thus the FACTS begin to come out. The superintendent knows, on his first trip, more about the *real* shop troubles than he ever dreamt existed before.

141. The effect upon the operators is also immediate. Sud-

denly they each find that the ***management*** knows exactly how they are performing their work—they cannot dodge it, they cannot rest

INSPECTOR'S DAILY REPORT

PART NO. F1 .... OPERATION 1st Screw ... DAY .... DATE February 22, 1916 ... DAY NIGHT

CLOCK NO.	MACH. NO.	OPERATOR'S NAME	TIME LOST	HOURS	AMOUNT PASSED	AVERAGE PER HR.	RE-OPERATED	REJECTED MACH.	REJECTED FDRY.	TO BE RE-OP	TOTAL WORK
1471	127	B SOMMERS		10	105	10.5	5	9	1		120
1438	129	E. HANSELMAN		10	149	149		9	17		175
1527	128	M. WOMACK		10	100	10		3			103
1446	144	N. STOUT		10	167	16.7		7			174
1597	136	A. ARNOLD		10	134	13.4		5	1		160
2020	126	M. HUFFMAN		10	123	1.23		19			142
1534	148	E McMURTIN		10	171	17.1		5	1		177
TOTAL											

JOB SETTER NAME S. ECHARD .... AVERAGE PER HR. 13.5 ....

OPERATORS NO-TODAY 7 .... SHOULD BE 7 .... ABSENT ....

CLOCK NO.	MACH. NO.	OPERATOR'S NAME	TIME LOST	HOURS	AMOUNT PASSED	AVERAGE PER HR	RE-OPERATED	REJECTED MACH.	REJECTED FDRY	TO BE RE-OP	TOTAL WORK
TOTAL											

JOB SETTER NAME .... AVERAGE ....

OPERATORS NO-TODAY .... SHOULD BE .... ABSENT ....

HOURS	AMOUNT PASSED	AVERAGE PER HOUR	REJECTED		TO BE REOPERATED	TOTAL WORKED
			MACH.	FDRY.		
OPERATORS	AVERAGE PER OPERATION	TIME LOST	MACH. LOSS	FDRY LOSS	% TO BE REOPERATED	
			%	%		

MACHINE SCRAP

WHY REJECTED	NO. PIECES	CHARGE TO

FIGURE 11.—Form for Inspector's Daily Report, Refer to Paragraph 139

easily because they are a "foreman's favorite," they ***know*** they will be caught if they slight their work and, best of all, will get a permanent unprejudiced record in their favor if they do well that will act to protect them against unfair discharge and will

assure them of promotion on merit. This will be dealt with in a separate chapter.

142. The managers may sit at their mahogany desks, glancing wisely at their graphic charts and having "conferences" with their superintendents and others. They may issue orders "until they are black in the face," fondly imagining that all their troubles will be over when their orders are issued. Yet! The way those job bosses with their foremen run their little groups of workers and tools in their small departments has far more effect on getting the work out well or badly—at low and high cost—than all their orders which are probably thoroughly distorted and misunderstood by the time they get down to the workmen.

143. The manner in which these small job bosses and foremen handle their labor under them, with fair or unfair discharges, fairness or favoritism in promotion and apportionment of jobs, recognition of merit or stealing of suggestions form the *real* factors in the labor situation.

Production Reports on Special Contracts

144. In the previous paragraphs we have been dealing with production reports on standard stock parts. It is of equal importance that comprehensive reports covering production on contracts that can be termed "special" be made out. Such contracts do not involve the duplication of parts but are of such a character that will require the ordering of special materials and the machining or other production of parts according to blueprints which may be dissimilar to anything produced previously.

Combined Reports—Stock Routing and Tracing—Costs

145. I have found it possible to economically combine production reports, reports on stock routing and tracing, cost reports on one sheet when dealing with special contracts. In order to get a conception of value and force of these production reports it becomes necessary to treat briefly, of the handling of these special contracts from their inception, through the engineering department, the raw materials stores, the factory and finally through assembly.

Raw Materials Stores for Special Contracts

146. The raw materials stores must deal with especial care with materials which are to be ordered and received on such special

contracts for a failure to secure material on time on special contracts always results in a serious situation. Again, too, such materials are often of a special character and are difficult to secure, or if they are standard the quantity required is so small as to make it difficult to secure it. While the chapter on stores department will treat fully with this, I give herewith a brief statement of the best method of handling special contracts and will then lead up to the question of production reports.

Engineering Department

147. It is, of course, to be assumed that when a special contract is secured, the drawings for this go into the designing and drafting departments in order to have the details drawn up and blueprints prepared. We will, therefore, assume that this has been done. It should be noted in passing, however, that on the blueprints for each part shown there should be listed up a brief specification of the materials:

(1) Materials to be used;

(2) Routing that the part is to take through the shop. That is to say, the blueprints should show the sequence of operations and the machine tools upon which the operation will be performed;

(3) It is also important that the prints should contain a clear statement as to the allowable tolerances.

Raw Material Requirements

148. The engineering department or the drafting department should prepare a statement of the quality and quantity of all materials required of every character which are to be used on this contract. It is important to note that nothing must be omitted, not even standard screws, rivets, etc.

149. This department should then combine all materials of a similar size and character in groups and should prepare a material specification as per form shown in Figure 12.

The Blanket Requisition

150. This forms a complete and very simple blanket requisition. This requisition together with three duplicate copies, is sent to the stores department. The stores department sends these three copies to the purchasing department which department places on the blanket requisition the prices of materials together with their estimate of the total costs.

BLANKET REQUISITION DATE AUG. 22, 1919.

CONTRACT NO. 43602 FOR VAULT LOCKING DEVICES

DELIVERY REQ'D BY JAN. 23, 1920. RAW MATERIALS MUST BE IN BY OCT. 16, 1919.

PART	BLUE PRINT NO.	KIND OF MATERIAL	BRIEF SPECIFICATION	QUANTITY REQUIRED	AMOUNT IN STORES THAT CAN BE APPLIED TO CONTRACT	NET AMOUNT REQUIRED	ESTIMATED PRICE PER	ESTIMATED TOTAL COST	ACTUAL PRICE PER	TOTAL ACTUAL COST	DELIVERY DATE
BASE.	86AH	STEEL FORG.	TENS. ST.-60000	468	120	348					10/1
BOLT BARS.	93BK	MACH. STEEL	2½x4-COMM.	4000 LB.	2600 LB.	1400 LB.					10/1
FRAME BARS.	96BK	″ ″	2½x2- ″	2400 ″	2400 ″	NONE					9/15
UPRIGHTS	84KL	″ ″	3x2- ″	1400 ″	NONE	1400 LB.					9/15
HORIZ.	81KL	″ ″	1½x1½- ″	1150 ″	200 ″	950 ″					9/12
BOLTS.	95H	COLD ROLLED	2″ ″	2600	300	2300 ″					9/20
BARS.	110F	″ ″	1″ ″	1150	NONE	1150 ″					9/20
BOLTS.	86K	″ ″	¾″ ″	1000 LB.	800 LB.	200 ″					10/2
SPECIAL SCREW.	91F	″ ″	1¼″ ″	1200 ″	600 ″	600 ″					10/7
HOLDERS.	52K	BRONZE	TOBIN	600 ″	NONE	600 ″					10/16
B.B. SUP'TS	50L	″	¾″ ROD TOBIN	2000	250	1750 ″					10/16
SUPPORTS.	49L	″	CASTINGS TOBIN	400 ″	NONE	400 ″					10/1
CAPS.	36L	BRASS	¾″ ROD COMM.	3000	900	2100 ″					9/25
CAPS.	39L	″	1″ ″ ″	4000							
WASHERS.	43K	″	1″ ″ ″	1000							
BUTTONS.	34L	″	1″ ″ ″	500							
BOLT SUPPORTS.	28K	″	1″ ″ ″	1100							
TOTAL.		″	1″ ″ ″	6600	4100 LB.	2500 LB.					9/30
PLATES	16K	O.H. STEEL	105″x40″x1″-60 MTS	34000							
″	14K	″ ″	″ ″ ″ ″	42000							
″	12K	″ ″	″ ″ ″ ″	26000							
TOTAL.		″ ″	106″x40″x1″-60 MTS	102000	46000	56000 LB.					9/25

APPROVED APPROVED

.... ENGINEERING GEN'L MGR. ....

.... STORES TREASURER ....

.... PURCHASING EXEC. COMM. ....

FIGURE 12.—Form for Blanket Requisition for Raw Material, Refer to Paragraph 149

151. This blanket requisition then goes to the treasurer and the executive office. The officials by examining this blanket requisition see the aggregate amount of money involved and also note carefully the character of the materials to be purchased.

SIMPLIFYING THE OFFICIAL "O. K."

152. The officials, if they approve of this requisition, then place their O. K. on same, retaining one copy and sending one copy to the purchasing department and the other copy to the treasurer. If any of the officials have any connections through which they believe they can secure advantageous prices on deliveries on materials shown on the blanket requisition, they are thus enabled to

note same and take it up and work it out in conjunction with the purchasing department.

The Treasurer Checks All Purchase Orders Against the Blanket Requisition

153. The purchasing department having before them this approved blanket requisition then sends out and secures their quotations. They then make out their regular purchase orders, making as many duplicates as the general practice of the concern requires. These purchasing orders before being sent out to the producers are sent to the treasurer for his approval. He carefully checks these purchase orders against the original O. K.'d blanket requisition, jotting down on the requisition the amounts contained on these purchase orders. Thus the treasurer is enabled at all times to know whether or not the purchasing department is ordering materials as it should and is also able to *prevent it from overbuying.*

154. Oftentimes on the important items the treasurer or general manager will require the purchasing department to send in a report showing quotations and promises of deliveries that have been received from various concerns together with recommendations of the purchasing department so that the treasurer's department may be in full possession of all the facts in connection with any heavy purchases to be made.

155. The purchase requisitions after being checked up by the treasurers' department and O. K.'d by them, are then returned to the purchasing department for them to send out, thus completing the official APPROVAL of purchase.

The "Follow Up" Date

156. It should be noted that in the blanket requisition there is a space provided for the insertion of the dates that materials must be received. This provides for a good check on the purchasing department which may be required to report to the treasurer or other officials the progress that is being made by the manufacturers in supplying such materials.

The Great Advantages of This Blanket Requisition

157. The system of using this blanket requisition provides the management with a picture of exactly what they have to purchase,

the amounts of money involved, keeps the purchasing department from over-ordering and simplifies greatly the question of O. K.ing requisitions.

158. When the purchasing department sends out the official purchase order a copy of this (without prices) should be sent to the stores department so that they may know the date of the order, from whom it was ordered and when it is supposed to be received. The stores department may require the purchasing department to report to it every week relative to the progress of the manufacturers in filling these orders.

159. When the material arrives the quantities are checked up by the stores department and the quality is checked up by the inspectors who have been supplied with the full specifications of the materials by the engineering or drafting departments. The question of inspection is so important that it will be dealt with in a separate chapter.

Delivery of Work to the Factory

160. The raw stores department having a notation as to the time when the work should be furnished to the shop will deliver the materials to the production department in ample time to allow

JOB NO.................. BLUE PRINT.......................... DATE...................

CONTRACT NO.......... DEPARTMENT .... PART...................

STARTED	ENDED	TOTAL TIME	TOTAL WORKED	REJECTED	TOTAL ACCEPTED	DAY WORK RATE	DAY WORK EARNINGS	BONUS RATE	BONUS EARNINGS	TOTAL EARNINGS	

INSPECTOR.................. FOREMAN ....

OPERATOR..................

Figure 13.—Machine Operator's Time Ticket, Refer to Paragraph 161

the production department to finish the work within the specified time. As noted later, it is not always wise to wait for the production department to send a requisition for this material to stores but it is far better for the stores department to put *the work into production at stated times.*

161. The operators performing machine work register their time on a time ticket similar to the one shown in Figure 13.

180. It is not at all necessary for a concern to use exactly this form of ticket as it is probable that the existing tickets in use will be of a satisfactory character, but the data shown on this simple ticket should be included on any ticket, no matter what its form.

163. These time tickets of the workmen then go into the factory systems department, which can well be combined with the cost department where they are entered upon proper forms. The form shown in Figure 14 is simple and effective.

CONTRACT FOR .... NUMBER .... MUST BE COMPLETED BY ....
PART .... BLUE PRINT NO. .... NUMBER OF PARTS NEEDED ....
MUST BE STARTED BY .... ORDERED OUT OF STORES .... DELIVERED TO FACTORY ....

DATE TIME TICKETS	DEPT.	WORKER'S CHECK NO.	TIME SPENT	LABOR COST	ESTIMATED LABOR COST		DEPT.			DEPT.			DEPT.			DEPT.			
							IN	SHOULD BE OUT	ACTUALLY OUT	IN	SHOULD BE OUT	ACTUALLY OUT	IN	SHOULD BE OUT	ACTUALLY OUT	IN	SHOULD BE OUT	ACTUALLY OUT	

FIGURE 14.—Summary Form for Workmen's Time Ticket, Refer to Paragraph 163

183. This form contemplates the entering of the time tickets daily. Later I will show a form which is much similar and in which the entries can be made weekly. Whether they shall be made daily or weekly depends largely upon the character and importance of the work.

In column 1 I show the dates contained on the time tickets.

In column 2 I show the department in which the work is done.

In column 3 I show the "workers' check number."

In column 4 I show time spent.

In column 5 I show the actual cost day by day.

In column 6 I show the estimated cost.

165. The estimated cost will be for each particular department and when the job moves from one department to another, the actual cost will be added up so that a comparison can be made.

THE DELIVERY SCHEDULE

166. The final columns showing the departments in which the work is to be done are of great importance for stock tracing purposes. The list of the departments to be placed in each column will be filled in with ink, this list depending upon the routing determined by the engineering or the designing department.

167. As will be shown later, the stock tracing department must build up a careful schedule of deliveries from each department, all depending upon the promised delivery date to the customers.

168. The columns in this report under each department are as follows:

169. The first column "IN" will show the dates in which the work has gone into the department and has been charged to it.

170. The second column "SHOULD BE OUT" shows the date that the stock tracing department has already determined for the completion date in this particular department.

171. The third column "ACTUALLY OUT" shows the date the work was actually out of this particular department.

172. It will readily be seen that the prompt completion of a special order will depend entirely upon the way in which the original schedule of deliveries from the different departments is adhered to and it is then perfectly clear that a stock tracing department is in the best position possible to regulate the flow of materials when they have before them such data.

173. Each foreman in each of these different departments should be notified of the time that the work is expected out of his department when the work first goes into it. If he finds any conditions in his department which would make this impossible he is to notify the stock tracing department immediately so that steps can be taken to overcome any unexpected difficulties.

Location of Stoppages

174. Thus again, we have the immediate location of any stoppage beyond the scheduled time. When this occurs, then ***immediately*** comes the investigation of its causes—bad or insufficient machines, bad work on preceding operations, machine tools busy on other work or possibly broken down, insufficient labor supply, tools worn, shortage of small tools—any one of the thousand of shop troubles.

175. The real reason will come out and when it does, then vigorous steps can be taken to overcome the difficulties.

176. The stock tracing departments must keep in touch with the different production departments in order to see if they are maintaining this schedule.

177. It will thus be seen that this simple form of report is very comprehensive. It supplies the management with a *real production report* and enables the stock tracing department to keep in the closest touch with conditions.

178. *It gives the management a real control.*

179. The stock routing and tracing will be the subject of a later chapter but this report on production of special contracts is so tied up with stock tracing, stock routing, and costs that a description of the methods cannot be avoided at this point.

Combining This Work with Costs

180. It is obvious that much of this work can be combined with the cost work. But the vigorous tracing of stock to maintain a proper flow of materials through the shop is of such fundamental importance that it must *not* be combined with cost work if this is to mean any delays.

181. It is for this reason that I advocate the placing of the cost department under the factory control. If this is *not* done then the stock tracing department must be kept separate as a factory department and the entries made there first even though work be duplicated. The very life blood of a good stock tracing department is promptness and to get this it must have control of its own data.

HOW TO MAKE BEST USE OF THESE REPORTS

The Main Production Committee

182. First, form a main production committee. This should be made up of the manager of works, chairman, with the superintendent of machine room production, superintendent of assembly, superintendent of inspection, superintendent of factory system (controlling all stores, stock tracing, production and efficiency reports), the chief engineer, and a good stenographer. This group of men form the "cabinet" of chief advisers and heads of divisions for the manager of works.

183. This committee should meet every day, preferably directly after lunch, before they plunge into the afternoon's work. A full description of the scope of this committee's work is given in the chapter on "organization."

184. However, one of its main duties is to consider in as brief a manner as possible the production report for the previous day together with reports upon conditions that may have arisen during the morning.

Each committee is of an *advisory character* only. The factory

manager and the superintendent, who are the chairmen of the various committees, have the final decision and authority, and issue their own orders after discussing matters in the committee meetings.

The Program

185. Each shortage in production is taken up, item after item, and the superintendent in whose department the shortage occurred must explain exactly why any such condition existed. Should the fault lie with any other department such as tool room or stores or stock tracing, then the superintendent of such division must explain the reasons for it and the steps already taken to overcome, setting a positive date for overcoming the trouble, which date is set down by the secretary to be followed up vigorously and reported on *at each meeting.*

Failure to Act Quickly Is Inexcusable

186. The *one unforgivable sin* is the failure of any superintendent to fail to act the *instant* the emergency arises. The man who is actually responsible must act immediately and woe betide him if he comes to this daily meeting and has to report that he has not acted to remedy any serious situation because he "put it off" or "forgot it" or, worst of all, "some member of his organization didn't do it." Absolutely no excuse can be accepted or dare be offered. Your men will soon learn this lesson if this be an iron-clad rule and you may rest assured that then not a man will appear before his associates with anything undone.

Trace Pending Matters

187. If any serious matter will require some days to overcome then the superintendent responsible should report progress *each day.* This keeps them on their toes.

188. These meetings should not last over 20 to 25 minutes—everything can be covered if the long-winded ones are compelled to shorten their stories.

The Condensed Report

189. A condensed report should be gotten out the same afternoon by the secretary, a copy to go to the manager of the works, sometimes an additional copy to the general manager. This can be typewritten.

190. Thus each superintendent is notifiel:

Such a method will keep them all "up and doing." And this *has* to be done. There can be no trusting to luck or to a foreman's promises in running a big shop.

The Subsidiary Committees

191. Under this main production committee comes the superintendent's committees—there will be a machine production committee, an assembly production committee, inspection committee, factory system's committee, engineering committee.

192. The superintendents of machining, assembly and inspection will have from three to five of their most important foremen on this committee—the superintendent of factory systems will have his head stock tracer, purchasing, stores, costs on his committee. The chief engineer will have his head of designing, tool room, tool supply and experimental on his committee, as will be shown in the chapter on organization.

Opposition to be Expected

193. Right here I will say that often your superintendents will not take kindly to this committee scheme. They are too wedded to their old autocratic rule and do not care to have their foremen take too large a share in the management. But the great benefits to the company of getting the co-operation, advice, suggestions from the best brains you have, the enthusiasm this plan imparts to your foremen, the tremendous educative influence of it all, the real *binding together* of these powerful groups into units that you can really control, immensely overweighs any such prejudices.

194. The superintendents must be forced to accept this plan and to *keep it up*. After they know of its immense advantages and begin to feel the lightening of their burdens they will become wedded to it.

195. I have such committees meet each morning at nine o'clock after their departments are well running. The meeting must be short and snappy, never lasting over 20 minutes—preferably 15 minutes. To anyone saying that it is inadvisable to pull the foremen off their jobs for 20 minutes each day I can only reply that then the shop must be poorly organized.

196. Each foreman reports his troubles in a brief manner and explains whose fault it is. The superintendent will require each foreman to explain reasons for the previous day's fall down, using

the production reports for this purpose. The superintendent then has a list of his foremen's troubles and is thus certain of his ground in each case.

197. Each production man will usually have troubles located with stores, stock tracing, tool room, purchasing. He will, as soon as the meeting is finished, go directly to the different superintendents and consult with them about these troubles. At first there will be many an explosion due to the unwillingness of the other superintendent to acknowledge his fault but, after such disputes are referred to the manager of works or the main production committee several times and are handled in a strong positive manner, the superintendents will find that it is best to settle *all* such matters amongst themselves before the meetings.

198. In the meantime, the factory system committee is considering the reasons for all complaints against its departments, stores, stock routing, purchasing and costs, and is taking strenuous steps to overcome each and every one.

199. The engineering committee amongst other things is requiring the head of the tool room to report on progress on every old tool being repaired and every new tool promised, comparing this with promised and needed dates.

200. Thus, when the superintendents attend the main production committee meeting they *know* the situation in their departments and know what they are talking about.

Blackboards

201. I have found that blackboards are very useful in holding all of these discussions. When any point under discussion is placed on a blackboard where all can see it it seems to make a much stronger impression upon the men than if the data were simply read off. They dislike to see their errors thus publicly advertised and will surely hustle to get their difficulties quickly rectified so as to prevent them being so shown.

202. The manager of works should make it a point to drop in on these subsidiary committee meetings at intervals so as to show his interest in the work and also come into personal touch with the foremen. Under no condition, however, should he take a leading part but should leave this to the superintendent in charge.

This Plan Relieves the Pressure

203. The whole factory management, manager of works and

each superintendent, will invariably find that these methods will soon relieve them of a great load of their former worries so that they can devote their time to the larger problems of management and not be buried under a mass of comparatively trivial difficulties which, however, *must* be taken care of.

204. By this plan the management gets the benefit of the best brains they have got—every good man is being educated to a higher degree every day, every problem is being wrestled with, not by one man's brains but by the brains of many, a real live feeling of co-operation and esprit-de-corps is being built up. The old much needed personal touch is being brought back into the business, and the management has a REAL CONTROL of every situation.

THE FACTORY SYSTEMS DEPARTMENT

Its Functions — Its Economies — Its Methods of Production Reports; Stores; Stock Tracing; Costs.

205. I HAVE usually found that there is a waste of money and loss of effectiveness in having departments such as stores, raw and finished stock tracing, production reports, efficiency methods, costs, under different heads and located at different points. There invariably follows a useless duplication of work and, in fact, a development of a lot of *useless* work under such conditions.

206. Every head of a department properly wants to make his department as important as possible, but often this influence leads to the production of a lot of records that no one looks at and no one uses. Just ask each of these department heads to send in a filled out copy of every record and every report they get out.

207. Then, after you have these records, require them to tell you just what effective use is made of them. Many of them will be found to be useless.

THE FACTORY SYSTEMS DEPARTMENT

208. I have found it to be a decided advantage to combine all of these departments into one which I call "factory systems."

This department gathers all the time tickets from which they make up the pay roll data.

From these tickets it makes up the production reports which guide the factory manager and superintendents.

From these same tickets it makes up the records showing the efficiency of departments, foremen, job bosses, operators, through

which the high standard outputs are reached and maintained. It thus locates unerringly the efficient and the inefficient.

From these records is secured the control of discharge, prevention of unjust discharge, also the control of production, through which the good operator will secure advancement.

From them it gets its scrap records locating the points where scrap is the greatest.

It holds control over stock tracing, using its output records as its basis.

Its records locate immediately for the factory manager or the superintendents the spots where any delay in production is occurring so that action to straighten out the situation may be taken.

Its control of stores as well as stock tracing insures a steady even flow of materials into the store room and thence into the shop.

Its control of costs renders complete its efficiency records. It thus makes it part of this department's business to report to the management the high costs so that a constant pressure and effort may be exerted to lower them.

209. Such a combination always results in large economies. In almost every department concerned with systems, there are periods during the week that are slack and the clerks are not fully busy. In this department such clerks are transferred to other work and kept busy. Then, too, all duplication of work is cut out and all useless records are eliminated. This plan always saves large sums over the cost of running these departments separately.

This Department Gives Control

210. Such a department should be responsible only to the factory manager or chief superintendent. It soon becomes his right hand. Its records show clearly what is going on in each spot in the shop. It gives the management a *real control* of the shop production and all of the shop conditions.

211. The man at the head of factory systems should be one of your best While he should have a knowledge of accounting, he should also know much about production matters. He should make the superintendent and foremen feel that the work and records of his department are *for the purpose of helping them.* They should be encouraged to go to factory systems whenever they need data on their work.

212. Factory systems, properly organized and properly run, will be a great money saver and a great aid toward increasing production and reducing costs.

CHAPTER IV

CONTROLLING THE FLOW OF PARTS THROUGH THE FACTORY. LOCATING ALL DELAYS AND DIFFICULTIES—OVERCOMING THEM

Stock Routing and Tracing

Preventing delay in Assembling Department; Keeping workmen supplied with parts to prevent loafing; Notifying Foremen what to work upon; Locating every shortage and shop difficulty immediately; Overcoming them; Reducing working capital needs; Handling Finished Stores; The Rush List; Machinery and Tool surveys.

1. The control of the flow of parts through the factory from raw stores to finished parts stores is one of the biggest and most important functions in all of shop management. A moment's consideration of the work of a stock routing and tracing department will immediately impress their importance on any manufacturer's mind, even though this may be, as it usually is, a much neglected development in his own shop.

What the Stock Routing and Tracing Department Controls

2. The stock routing and tracing department performs the following functions:

A. It is responsible for keeping the assembling room provided with an ample supply of all parts when needed, so that there can be no possibility of any delay.

B. It keeps the departments and workmen constantly provided with a proper supply of material, its methods resulting in a steady, constant flow of materials throughout the shop.

C. It keeps each foreman constantly notified of just what lots of stock and what parts he should work upon and also what parts he should rush.

D. Its methods provide that *any shortage or difficulty* of any nature whatsoever, will be immediately disclosed, the department

wherein it occurs will be located, and the responsibility for the delay or difficulty fastened upon the proper party for immediate correction.

E. Its work provides for the taking care of any emergency that arises from extraordinary causes such as the discovery of defective material that may have gotten into the shop, etc.

F. Its work, when skillfully carried out, will invariably result in the cutting down of the working capital which must be invested in the work in process of manufacture to a minimum.

Discussion of "A"

3. *A.* It is responsible for keeping the assembling room provided with an ample supply of all parts when needed, so that there can be no possibility of any delay.

4. Any experienced production man knows that one of the greatest causes for delays in production of the finished article and for excessively high cost in assembling is the retardation of assembling due to lack of parts when needed. The bane of every assembling superintendent's life is the discovery almost daily of shortage of parts in the finished stock room when he sends for them in order to continue assembling.

5. When you compare the ordinary shop when it is run under the ordinary conditions wherein the assembling department production is continuously stopped because of non-production of parts, with the same shop when these troubles are overcome through an efficient stock tracing system, the assembling department being continuously supplied, the difference is invariably so great as to be startling.

6. I have seen the production of any number of assembling departments more than doubled with the same number of operators and the same equipment after this difficulty was once thoroughly overcome.

Discussion of "B"

7. *B.* It keeps the departments and workmen constantly provided with a proper supply of material its methods resulting in a steady constant flow of materials throughout the shop.

8. There is no question at all but that in the ordinary shop the amount of time lost due to lack of flow of materials to the operators is extremely serious. If any manager is not convinced of this fact, let him go into the shop, select one department, and stand

there for three or four hours and see for himself how the work is retarded because of the lack of this steady flow of materials. It will be safe to say, that under average conditions, 20% of the time of the operators is lost due to this condition. The firm, of course, is paying for this, either through their day rate, or increased bonuses, or through piece-work prices that are placed so high as to make allowances for this condition.

9. The workers must have materials to work on close at hand at all times, and they must not wait between jobs. An efficient stock tracing system will take care of this.

Discussion of "C"

10. *C*. It keeps each foreman constantly notified daily of just what lots of stock and what parts he should work upon and also what parts he should rush.

11. There is no work in a shop more important than this. How is the shop foreman to know just what he is to work upon unless someone in authority notifies him? He may have 100 jobs waiting on his department and he may have a capacity to work on only 40 of them. If he is left alone to work upon these without guidance, the chances are that he will select a large number of jobs to work upon when the stock rooms are already supplied with a large amount of these finished parts, while this same stock room may be needing some of the other 60 jobs very badly.

12. Ordinarily, the foreman does the best he can—selecting his own jobs to work upon—and then when the stock tracer rushes down to his department during the day and notifies him that the finished parts stores are almost out of parts and that it is necessary for him to rush them through to the neglect of everything else, he usually finds that his machine tools are already set up on some long job and that it is a long and tedious process for him to tear down and set up on the new rush job.

13. How much better is it to guide him each day on correct data secured from the finished parts stores, notifying him just on what parts he is to work upon and, in emergency cases, what parts should be "RUSH." With the suggested system, in case parts are "RUSH" there will always be enough time to get them through to the finished parts stores *before* there is any *real shortage.*

Discussion of "D"

14. *D*. Its methods provide that any shortage or difficulty of

any nature whatsoever, will be immediately disclosed—the department wherein it occurs will be located—and the responsibility for the delay fastened upon the proper party.

15. The mere stating of this factor in stock tracing is sufficient to denote its importance. Keeping in mind the fact that "the big difficulties are made up of little ones" and that if the "little ones" are attended to there *will be no* "big ones," it will be seen that any method of detecting and locating these smaller difficulties and forcing their correction will be a factor of the greatest importance in efficient management.

16. When the stock tracing department directs the different foremen to work upon certain parts and get them out within a certain time, the foremen are then supposed to state immediately any reasons that may exist *why this cannot be done*. These conditions may cover shortage of tools, tools being repaired, defective tools, insufficient machinery, machinery not repaired, unusual scrap, shortage of material, defective material, lack of operators, poor operators, etc. As will be developed later, *whatever the cause*, this will be noted by the stock tracing department, referred to the superintendent and *immediate* steps taken to overcome the difficulty.

Discussion of "E"

17. *E*. Its work provides for the taking care of any emergency that arises from extraordinary causes such as the discovery of defective material that may have gotten into the shop, etc.

18. Naturally, the same methods described above will take care of any sudden emergency that may arise of any serious character. These may be caused by the sudden and unexpected discovery of defective materials—a serious breakdown in a group of machinery or accidents of a similar character.

Discussion of "F"

19. Its work, when skillfully carried out, will invariably result in the cutting down of the working capital which must be invested in the work in process of manufacture to a minimum.

20. This is a very important part of this work. In the usual shop there is ordinarily a large amount of stock lying around which would be really unnecessary if the parts were guided through the shop on regular schedules. It has invariably been found that when an efficient stock routing and tracing system was put into

a shop and was operating properly that there resulted a gradual decrease in the investment required in materials and labor and work in process which often amounted to a large sum. This is by no means one of the least important functions for very often it is possible to make a 15% to 30% reduction in the investment required in work in process alone and this often represents a large sum of money.

21. In developing my system of stock routing and tracing, which is in efficient use in many shops, I avoid all possible complications. The system advocated is adapted to the regular courses of manufacture of any shop and does not involve any radical changes in method or procedure.

STARTING A SIMPLE AND EFFICIENT METHOD OF STOCK TRACING

The Production Schedule

22. The first step in all cases is to determine upon a production schedule for each article produced. This should be in accord with the demands of the sales department. Production schedules should be revised every three months as sales conditions change and factory production must take account of such changes, not only to care for increased demand of the Sales Division but also to avoid accumulating large amounts of materials for products, the demand for which may be lessening.

23. Such production schedules are given to all superintendents and foremen. The head of the assembling department thus knows what he must produce each day—the stock tracing department, controlling the flow of materials through the shop, knows how many parts of each kind must be supplied to the assembling room each day and the superintendent in charge of the production of parts knows how much his department must finish for proper periods in order to meet this daily average.

24. It is obvious that the ideal plan is to work from such a production schedule and arrange a broad comprehensive plan whereby a regular schedule is worked out for each lot of parts and each group of machine tools so that the machine tools may start and complete work on various jobs in accordance with such a schedule and thus ensure a clock like precision which will reduce to a minimum the parts in process of manufacture and make certain deliveries to the assembling room at proper time. However,

unless the equipment is arranged for progressive manufacturing so that parts flow in a continuous line from one operation to another, this is a difficult matter to accomplish, unless the product is a very simple one. It usually involves heavy overhead expense owing to the number of clerks needed to run it properly. Again, the prearranged schedule is being continually disturbed because of the many unforeseen occurrences in a shop such as tools needing repair—machinery broken down—new and poor operatives, etc.

The Simplest Plan

25. In most cases the simplest and most effective plan will cover, 1st. The delivery to the factory (1st operation) at regular intervals a scheduled quantity of raw materials for each part; 2d. The carrying in finished parts stores of a sufficient number of each part to take care of the needs of the assembling department; 3d. A vigorous system of stock tracing which will control the flow of materials through the shop—keep the foremen well supplied with parts—notify them what parts to work upon—guide the parts into finished parts stores so that they will arrive in time to meet the needs of the assembling department.

Deliver Materials at Regular Intervals

26. Having determined the volume of each product that must be completed each day, it is evident that there must be delivered to the shop at regular intervals enough raw materials of all kinds to make up the number of parts required plus a proper allowance for scrap which amount may be based upon past performance.

27. The amounts of materials to be delivered at any one time and the proper dates of delivery, will depend upon the character of the part—its ease or difficulty of manufacture—the machining and tool capacity—taking into account the need of all the different products.

28. For instance, some parts difficult to manufacture may be delivered to the first operation daily in case the machining capacity can take care of this and other parts. In such a case, the daily deliveries will equal the amount required for the daily assembly plus allowance for scrap.

29. Or, it may be impossible to use the particular machine tools required for this product for more than three days a week.

In such cases, the schedule will provide for the larger amounts to be delivered upon certain days of each week.

30. In other cases, the possible daily production off of a machine tool (for example, an automatic screw machine) may be greatly in excess of the requirements. In such a case the production schedule would provide for the delivery of raw materials to such an operation at specific intervals—once a week or once every two weeks as the case may be.

31. These factors depend upon the production requirements of each product—the machining capacity and the time required to get the parts through the shop.

Delivery of Materials According to Schedule

32. As I will show later it is fatal to any real production program to permit the practice of requisitioning of materials from stores by foremen or superintendents, whenever they feel the need of materials to work upon. They cannot know the needs of the assembling departments. They are often led to start work on parts of which there are a large over-supply already in the shop while a serious shortage of other parts may be threatening. This is a common practice but is fundamentally wrong.

33. When the shop is working properly under a production schedule the amount of each kind of material to be delivered and the date of these deliveries to the shop is determined and based upon the shop conditions.

Material Piles Up if the Foreman Does Not Use It

34. These materials are delivered upon these dates regardless of whether or not the superintendent and foremen are ready for them. The deliveries are made and then, in case they cannot be used promptly, they begin to pile up.

Hunting the Trouble

35. When this happens, the hunt for trouble begins. Machine tools or tooling may be inadequate—bad materials or preceding jobs may have slowed up the work—tools may be under repair—any one of a dozen things may have happened. But, whatever it may be, the stores department *keeps on delivering the raw materials* according to schedule regardless of its accumulation.

36. The effect of this is well nigh magical. The piling up of these materials is a severe indictment against the foreman responsible for the job. He cannot get away from it. Never have I found the foreman who could not find some way out of his difficulty.

37. Undoubtedly, it is difficult for the ordinary shop to calculate out any production schedule that they can at first adhere to with regularity for there are many factors in production that will prevent this, especially at the beginning. Therefore, it will not be profitable to be too hasty in piling up deliveries on the first operation until the plan has gotten well under way and the shop is accustomed to it. But any shop man will realize that it is only common sense to work out such a production schedule and deliver raw materials in accordance therewith.

This Will Disclose Causes of Troubles

38. Such a plan will speedily develop the causes for all sorts of troubles. The first job may suffer from insufficient machinery—or inefficient tooling—or too low a supply of raw materials, all of which must be overcome quickly.

39. The balance of the work on Stock Tracing is so direct and simple that it may be started at once while the problems connected with the regular delivery of raw materials according to schedule may be worked out.

40. In instituting a proper stock routing and tracing department, it is, of course, necessary to consider and solve the problem of proper stock routing before the department can be developed to its highest point of efficiency. Very often, however, this going over of the routing is a rather long proposition and however valuable and necessary it may be, it may prove unwise to hold back the work of stock tracing while the routing is being investigated.

41. The benefits to be secured from this simple system of stock tracing are so great that I will attack this work immediately, with the understanding, however, that the routing must come along with it as the part of a factory system. Therefore, it must be understood that while I start with a description of stock tracing, still the routing itself must be gone over carefully before the system can be considered wholly complete.

Stock Routing and Tracing

42. The stock tracing department, as stated previously, has absolute control of the direction of the flow of materials going through the factory, and their storage in the finished parts stores. In some establishments, the finished parts stores is controlled by the stores department, they having under their control both the raw stores and the finished parts stores. It is so important, however, that the stock tracing department secure accurate data in regard to the status of finished parts stores that it is usually desirable to

BIN CARD **FINISHED PARTS STORES**

NAME OF PART *F 63 – Base Forging*
USED ON *Register No. 81 and Register No. 125*
DAILY CONSUMPTION *1000 on No. 81 and 1000 on No. 125 Total 2000*
NUMBER OF DAYS REQUIRED TO GO THROUGH SHOP
WORK LIMIT *16000* RUSH LIMIT *5600*

DATE	RECEIPTS	DELIVERIES	ON HAND	ON HAND CHECKED		
				DATE	BY	

Figure 15.—Form of Card for Stock Room Bins, Refer to Paragraph 47

give them control of these stores, as a divided responsibility in this important matter is ordinarily not advisable.

43. Therefore, we will assume that the finished parts stores will be under the control of the stock tracing department, and will give a description of the method of keeping finished parts stores stock. These methods will apply to this stores room, whether the control is under the stock tracing or that of the general stores department.

Finished Parts Stores

44. Records in the finished parts stores are so essential as a part of a complete stock tracing plan that I will start with a brief description of the methods to be used in this stores room.

45. In the first place, all finished parts ready for the assembling

room, must be kept in a separate stores room, in proper bins. It is a great mistake to allow finished parts to be stored, "HIT OR MISS" around a factory, as they not only become injured and often scrapped, but also cannot be properly recorded.

46. This finished parts stores room should be located conveniently to both the machining room and the assembling rooms. The finished parts to each product should be always grouped together, excepting in cases where some one classification of materials, such as bolts, nuts, etc., are used on two or more products. All of the parts which are used on more than one product should be grouped together.

Bin Cards

47. Each bin of stock should have a rack which will contain a bin card, similar to the form shown in Figure 15.

48. As will be noted, the form shows name of part, product the part is used on, the number of parts used monthly by assembling department, "WORK LIMIT" and "RUSH LIMIT." (These two limits will be explained later.)

49. Column No. 1 shows the date, which date will be used for receipts, deliveries and inventories.

50. Column No. 2 shows the receipts of finished parts from the machine room—the quantity placed in this column and the date being placed in Column No. 1.

51. Column No. 3 shows the deliveries to the assembling room, the amounts being marked therein, while the date of deliveries is placed in Column No. 1. Sometimes an additional column is inserted after Column No. 3 to show the number of the withdrawal requisition, but this I do not consider necessary.

52. Column No. 4 shows the inventory, or net amount on hand, which, of course, is the difference between Columns Nos. 2 and 3. This column *must be filled* out each time that there is a receipt or withdrawal, so that there will be a constant record of the amount on hand.

Columns No. 5 and 6 shows when and by whom inventory is taken.

53. Column No. 7 is more for remarks, which is useful in recording any special notation, and for making special note when "WORK LIMIT" or "RUSH LIMIT" is reached.

Keeping Bin Cards "Up to the Minute"

54. It is *absolutely essential* that the records on these bin cards be kept up to the minute, and that *they be accurate.* Nothing will prove more fatal than carelessness in handling these bin cards, for they will prove the key-note of the entire stock tracing and stock routing system.

55. Competent, well-paid men must be selected for this work, in order to provide that the inventory, showing the amount on hand, is correct at all times. It is necessary that *during the month,* the contents of each bin be checked up and proper records be made on the cards. In order to do this easily, a *prescribed number* of bins should be *checked up each day* by counting the number of parts, and placing the number thereof on the bin card in Column No. 4, right below the last number shown by the stores keeper, the date of the inventory being placed in Column No. 1. A line should be drawn across the card below this figure, showing that this inventory was taken. A comparison between the inventory count figure and the figure as shown by the additions and subtractions of the stores keeper will show how accurately the stores keeper is keeping the records.

56. It is easily possible for an active stores keeper to go through the entire number of bins, once a month, by apportioning each day a certain number of bins for examination and count, having this routine all scheduled out, and *being certain* to make this inventory and count during the odd moments when he is not otherwise occupied. In the average stores room, there are periods during the day when the stores keeper can find ample time to do this work.

57. I cannot criticise too strongly the habit of putting incompetent men in the stores department. Your stores represent your dollars. The keeping of these stores records is a job for a high grade well-paid man with "a nose for accounting." The usual men who possess no qualifications other than physical strength and a knowledge of the parts "WILL NOT DO."

Consideration of "Work" and "Rush Limits"

58. These two figures are of such importance that special consideration must be paid to them. The "WORK LIMIT" is a figure placed by the stores keeper, which signifies that when the stock of parts in this particular bin is reduced to this figure that then the machine room *must* begin *to work actively* upon these parts.

This limit is placed at such a figure as to make it easily possible for the desired parts to flow into the stores room *before* the *stock of parts* is exhausted.

59. As an example, let us consider that an assembling room used one thousand parts of H-63 each day, and that they require on an average twenty days to get these parts through the shop, but that in cases of emergency, the parts can be rushed through in ten days or less. We, of course, must assume that the factory always has some of these parts in process of being manufactured, so that it is in no case necessary to bring through parts from the very beginning, it being part of the duties of the stock tracing department to see that there is a flow of a proper number of each part through the shop at *all* times.

60. In such a case, the "WORK LIMIT" would be placed at not over fifteen thousand parts. This, then means, that when the contents of the bins fall down to fifteen thousand parts, then the stock tracing department understands that active work is to be begun by the foreman on these particular pieces, as will be explained fully later.

IT WILL REFER TO THE PRODUCTION RECORDS, LOCATE THE DEPARTMENT CONTAINING THOSE LOTS WHICH ARE NEAREST THE STORES ROOM, AND NOTIFY THE FOREMAN OF THE DEPARTMENTS WHEREIN THE STOCK LIES, THAT WORK MUST BE BEGUN IMMEDIATELY AND FINISHED WITHIN A PRESCRIBED TIME. The stock tracing department, in the meantime, watches to see that the flow of these parts is maintained according to such a schedule as will bring the parts into the finished parts room before the stock gets so low as to be dangerous.

61. I bear with special emphasis upon this point, because a smooth running system of this kind will keep down to a minimum the items which *must be rushed* into the stock room, because of a serious shortage of parts. While, in any factory, the rush items will appear, due to various emergencies, still, it is bad management to have too many of them, and experience shows that when the foremen are notified, through such systems as this, of those parts upon which they must *begin* work, as noted above, then the RUSH ITEMS are almost eliminated.

THE RUSH LIMIT

62. In this case, the rush limit would be placed at five thousand parts which would give five days to rush the parts into the finished parts room. As stated previously, it is fair to assume

that some of the parts have already progressed into process of manufacture, so that a five-day leeway should be sufficient. Naturally, the determination of the number of days necessary to calculate on, will depend entirely upon the character of the materials, and the difficulty and number of the operations. Therefore, this period will be either shorter or longer, dependent upon the characteristics of the part under consideration.

63. When any stock in the stock bins gets down to this rush limit or in the example, to five thousand parts this, then, indicates that a real emergency has arisen on these parts, and that EVERYTHING MUST MAKE WAY FOR THEM. The stock tracing department, through their records, locate the parts which are nearest the stock room, then notify the foremen of the urgency of such cases. It must be understood by all foremen that anything on the rush list gets the necessary RIGHT-OF-WAY, and MUST BE PUT THROUGH THEIR DEPARTMENT WITH THE GREATEST RAPIDITY, NO MATTER WHAT THE CONSEQUENCES. For instance, a foreman may have spent several hours in setting up some machine for a particular job, and along will come the stock tracing department and notify him that another job is on the special rush list, which will require this same machine. Therefore, it becomes necessary for him to immediately tear down the entire job WITHOUT ANY ARGUMENT and start on the one for special rush.

64. The methods by which the foremen will be notified of the parts which are on the work list, and the parts which are on the rush list, will be described later.

The Authority of the Stock Tracing Department

65. In controlling the flow of parts through the factory, the authority of the stock tracing department must always be unquestioned, they being subject only to the orders of the superintendent. Infinite trouble is always caused if there is any question on this point, and if the foremen are allowed to use their judgment. They cannot possibly know what the conditions are, and therefore, are in no position to judge what they should work upon, on any particular day. This must be left *entirely* up to the stock tracing department, and the foreman must work under instructions coming from them in the name of the superintendent.

Examination of Cards

66. All stock bin cards must be examined before closing time

every evening in order to ascertain just what items of stock have been reduced to the work limit, and what items have been reduced to the rush limits. The reports for the foremen, which will be described later, must *invariably* be made out every evening, so that the foreman will have his instructions as to what to work upon on his desk the *first thing in the morning.* It is a fatal mistake to allow a part of the day go by before the foreman is notified of the parts that he is to work upon, for by that time, he has gotten a good start, and it causes serious delays and mix-ups to notify him at eight or nine o'clock in the morning. Therefore, the stock tracing and finished parts men should be kept overtime a sufficient length of time to examine the cards and make out the lists.

67. I found it an excellent plan to fasten special markers on bin cards which will indicate just what parts are down to the work limit, and what parts are down to the rush limit.

How to Locate the Parts in the Shop That Are Nearest the Finished Stores

68. The bin cards have been examined, and the stores keeper and the stock tracer have noted the parts which are down to the work limit and those which are down to the rush limit.

69. THEY HAVE BEFORE THEM *the production reports* REFERRED TO IN CHAPTER NO. 3 WHICH SHOW THE PRODUCTION ON EACH OPERATION ON EACH PART, THE AMOUNT OF PARTS *on hand,* ON EACH OPERATION OF EACH PART, AND THE DEPARTMENTS WHERE THESE PARTS ARE LOCATED.

70. FIRST TAKING THE CARDS WHICH SHOW THE PARTS WHICH ARE DOWN TO THE WORK LIMIT, THEY SELECT THE *production report* SHEETS FOR THESE SAME PARTS; THEY THEN, BY EXAMINING THE "ON HAND" COLUMN IN THESE REPORTS LOCATE THE DEPARTMENTS AND OPERATIONS WHICH ARE HOLDING THESE PARTS WHICH ARE NEAREST THE STOCK ROOM.

71. THEN THEY DO THE SAME ON ALL THE CARDS WHICH SHOW THE PARTS IN DANGEROUS CONDITIONS AND ON THE RUSH LIMIT. IMMEDIATELY THE EXACT LOCATION IS DETERMINED.

72. They thus locate quickly and exactly the lots of stock which must be handled with promptness.

73. The form of Figure 16 is self-explanatory. In the first place, the idea is to take all the parts which come under both the work limit and the rush limit, and group them according to the departments, located according to the production report data.

74. On one side of the report will show the parts which come

under the work limit and the other side of the report will show those that come under the rush limit. In each case Column No. 1 will show the department in which the work is to be operated on. Column No. 2 shows the name or number of the part. Column No. 3 shows the quantity of parts charged to this department. Column No. 4 shows the date at which these must come out of the department. Thus, the stock tracers will have before them each morning, a list which shows them just what each department is charged with, on either the work limit or the rush limit.

PARTS UNDER WORK LIMITS					Date Sept. 18, 1919 PARTS UNDER RUSH LIMITS				
DEPARTMENT	NAME OF PART	QUANTITY CHARGED	DATE MUST BE OUT	TROUBLES	DEPARTMENT	NAME OF PART	QUANTITY CHARGED	DATE MUST BE OUT	TROUBLES
PLANER	F16	65	10/3		PLANER	F 38	80	9/20	
	F32	45	10/5			H 56	110	9/20	
	H61	124	10/10		MILLING	G 152	360	9/18	
MILLING	H61	220	9/27	TOOL ROOM REPAIR FIXTURE		G 154	510	9/18	
	F43	460	9/29			K43	110	9/19	
	H54	310	10/4	CUTTERS BAD	DRILLING	K81	420	9/18	RUSH TOOL ROOM ON JIG
DRILLING	H36	84	9/28			G49	140	9/19	
	H18	165	9/29		PUNCH PRESS	A 56	2300	9/18	
	B26	2064	10/3			A64	560	9/18	DIES TOOL ROOM RUSH
	B41	1150	10/3	TOOL ROOM REPAIR JIG					
PUNCH PRESS	A 60	4250	10/3						
	A 15	10000	10/3						
	C23	10000	10/3	RUSH NEW DIES					

FIGURE 16.—Form Used to Locate Lots of Stock, Refer to Paragraph 73

they go from department to department they can cover, easily, each department in its entirety, and thus save needless running around.

NOTIFYING THE FOREMAN

75. It is an absolutely essential part of the plan that each foreman *must have on his desk, in the morning upon his arrival,* a statement of what he has charged to his department that he must start to work on for that day, this work being divided into the work list and the rush list. See Figure 16-A.

76. On the left-hand side of this form, the foreman will see those parts upon which he must start work at the earliest possible moment, without deranging his scheme of production. Column No. 1 will show him the name of parts. Column No. 2, the quantity required. Column No. 3 will be filled out by the stock tracer. No. 3 shows the date by which the foreman is to complete the work. No. 4 when the foreman estimates will finish, and No. 5

shows the notation of anything that is *preventing him from beginning*. The right-hand side, the report contains the same data covering the rush list. In the case of the rush list, this is to work automatically as a notice to the foreman that *everything is to be sacrificed* to get this work out of his department. Work must begin *immediately* on these items, regardless of any other condition.

Foreman Must Report What Holds Him Back

77. It is a very important part of this plan to provide for the immediate reporting by the foreman, and also by the stock tracer to the superintendent, of all difficulties which may be preventing the foreman from starting the work. Therefore, the foreman must re-

FOREMAN'S OUTPUT INSTRUCTIONS

To................ Dept.................. Foreman..................

PARTS UNDER WORK LIMITS					PARTS UNDER RUSH LIMITS				
PART	QUANTITY REQUIRED	DATE MUST COMPLETE	DATE WILL COMPLETE	TROUBLES	PART	QUANTITY REQUIRED	DATE MUST COMPLETE	DATE WILL COMPLETE	TROUBLES

EACH FOREMAN MUST WORK ACCORDING TO THIS LIST AND MUST REPORT IMMEDIATELY TO STOCK TRACER AND SUPER. ANY CONDITIONS THAT MAY CAUSE DELAYS.

Figure 16-A.—Form for Foremen's Output Instructions, Refer to Paragraph 75

port immediately, any and all difficulties that may be holding him back and preventing him from carrying out the work, as shown on this sheet. It is not necessary for him to wait and make a written report, as minutes are often precious, but he should have a small pad which he can use for this purpose, upon which he writes his pencil notes, which can be placed in the hands of his superintendent for *immediate action*. Hold him strictly accountable if he does not do this.

78. The stock tracer himself, who is in consulrtation with the foremen all day long, also notes all those items which may be holding up the foremen and the character of these, and it will then become his business to also notify the superintendent about these conditions. If, at the end of the day, he finds that these conditions have not been remedied, then he is to report again to the superinten-

dent as a strong reminder to the fact that these vital hold-ups have not been overcome.

Locating the Real Source of Trouble

79. It is perfectly clear that such a method will unerringly locate each and every possibility of shortage and each and every shop trouble and the exact party responsible for it. The whole plan will work most efficiently and can only fail when the management is unusually derelict in its failure to give prompt attention to these difficulties, minor though they may seem. The unvarying principle of those in charge of the management must always be that each day must take care of its own troubles, and no difficulties can be allowed to pass unattended to.

Stop the Recurring Shortages on the Same Parts

80. It often happens that shortages will occur, again and again. upon the same classification of materials. When this occurs, there is always some good reason for it that should be investigated and eliminated. It will be the duty of the stock tracer, the superintendent and the foreman to ferret these out. It is surprising to note how often the assembling room is constantly being delayed by a shortage of comparatively few kinds of parts, while the stock room may be filled full of other parts. This may be due to lack of the needed machine tools, or insufficient and poor tooling, or raw stock stores not putting sufficient parts into process of manufacturing.

Undoubtedly, such a situation demands special consideration for, if once these troubles are overcome, then it is overcome forever.

Stock Tracers' Report on Delays and Causes

81. The stock tracing department should make out for the management and superintendent, a monthly report which will cover the stock shortages for the month, and the reasons for them.

82. This report covers the total number of actual shortages that occurred during the month, resulting in actual delays in assembling room. It shows in what departments the delays occurred and what the real reasons for them were. The other portion of the report is devoted to the items which were on the rush list, giving the departments in which these were held up, and the reasons therefor, The bottom of the report should be filled out with the suggestions of the stock tracer.

Report Deserves Attention

83. This report must be watched carefully by the superintendent and manager, for it provides an excellent check upon factory conditions. All reasons for *continuous delays* must be investigated, and a full report made thereon, so that the reasons therefor can be overcome. All these reports will unerringly locate the responsibility for these serious delays.

84. It is not always advisable to have all of these forms *printed*. Mimeographed copies will serve as well. It is important, however, that forms be made out, for otherwise, proper reports will not be sent to those in authority. Foremen are human and dislike to report the faults of anyone else, either verbally or in writing, but they must realize that it is to the great benefit of the business and to themselves, to have these troubles overcome. They will not be overcome if they do not report them. I have always found that where a man had a form which he had to fill out, he would do this properly. Hence, I have always preferred to have these data prepared on forms as indicated.

The Solution of the Problem of Eliminating Shop Troubles

85. In this simple and effective manner, all the parts are guided through the shop. The foremen are guided in their work, the workmen are kept busy, the assembling-room delays are eliminated, and, best of all, every difficulty and trouble, no matter what its character, is located immediately and the responsibility is placed on the proper man or department, and effective action is forced.

The Reduction of Working Capital Tied Up in Dead or Slow-Moving Materials

86. When considering methods that can improve conditions in any business one of the first thoughts of the business man will be to convert as much of his tied-up working capital into cash as he can without crippling the business in any way.

Examination of the inventory of:

A. Raw stores;
B. Work in process;
C. Parts in finished stores.
D. Parts in the assembling room;

will show you what a huge proportion of the firm's working capital is tied up in such items.

87. The raw stores department which has control of the raw stock and supplies together with the stock routing and tracing department, which has charge of the WORK IN PROCESS and finished parts stores, control the largest proportion of the firm's invested working capital. It is a matter of serious importance to the firm to see that these requirements are reduced to an absolute though safe minimum. Ways and means can be found for doing this without in the slightest running any danger of crippling the firm's output.

Reduction of Scrappage from Changes

88. The reduction of stores and work in process to a minimum is important not only from the standpoint of reduction of working capital but also to reduce to a minimum the number of parts so that in case any of the product is abandoned or changed, there will not be a too excessive scrappage.

89. In passing it should be noted that when consideration is first being given to the possible abandoning or changing radically of any product the very first thing to do is to investigate the condition of stores and work in process so that proper restrictions can be placed thereon in order that the parts already worked up, either partially or wholly, may be worked into finished products as far as possible before the product is finally abandoned.

90. Time and again I have found the amounts of money uselessly tied up in this manner almost incredible. Generally, it is possible to easily make a reduction of 15% in this regard and sometimes much more.

Slow-Moving Materials in Stores

91. The stores department may be burdened with large quantities of materials which are not being used as rapidly as they should owing to the lack of co-ordination between the method of ordering raw materials and the speed with which production is going on in the shop.

Slow-Moving Parts in Process of Manufacturing

92. Then, again, there is often entirely too much stock tied up on the floors of the factory that is not moving promptly, this being due to a lack of proper control of the movement of stock through the stock tracing department.

Too Much Tied Up in Finished Stores

93. Again, the amounts of finished parts tied up in the finished parts stores is often too great in many directions; the usual condition being one where there are large quantities of parts which are *relatively unimportant* that are *always finished* and in the stock room while *important parts* and those which are *hard to get* through are *always short.*

The foremen, not being advised what to put through, do their best and as a result they will often have their machines loaded up with relatively unimportant parts to the great detriment of the important ones and this only means a further congestion.

The Way to Correct This

94. After the stock routing and tracing work has been working steadily for a few months the improvement in this regard will be very noticeable. It is necessary, however, that in connection with this stock tracing system the foremen and the stores department work in close co-operation with the stock tracing and do not put into process any unnecessary quantities of stock to add to the confusion.

Determining the Amount that Should Be in Process of Manufacture and in Finished Stores

95. It will not be long before the stock tracing department can determine exactly just how many parts should be *in the finished stores and in process* at any one time in order to keep the assembly room supplied for the output according to the production schedule. Once this is determined, the stores department will then not place any additional amounts into process until the existing amounts in stores and in process of manufacture are worked down to a determined upon amount and will then regulate deliveries according to the production schedule.

Balancing Up Parts

96. It will often be found useful to take your inventory of finished parts and work in process and show the total *number of completed articles that these go into.* By running down and making a comparison you will soon find a surprising lack of balance in all parts. This lack of balance can be corrected by shutting off temporarily the new supplies of that stock where the shop is *overloaded* and by putting in necessary amounts of materials or stock where the factory is *under-supplied.*

97. We must, however, keep in mind all the time that it is not at all necessary to have in process of manufacture an equal amount of all parts that go to make up any one product, for the big factor to be considered in this case is the length of time required to get the work through the shop, giving due consideration to the equipment. Naturally, there must be a large supply of those parts requiring the longest and most difficult operations in process of manufacture, while on the parts which can be gotten through speedily, the amount of this work in process can be cut to a minimum.

98. A somewhat primitive but very effective method, is to go over your bin cards and make a list of those which show the items that have not appeared on either the "rush" list or "WORK" list for a period of 60 days. It is safe to assume that any items that have not appeared on the work list for 60 days have entirely too many parts in stock and this alone is sufficient to direct attention to this and other similar items.

The Committee

99. The work of reducing the amount of working capital locked up in inventories can well be placed in the hands of a special committee of shop men and accountants after they have been thoroughly instructed in these points and they will quickly solve the problems.

Stock Tracing in the Assembling Department

100. Ordinarily, the stock tracing in the assembling department is a much simpler proposition than of any similar work in the machining division, especially when the assembling department is being supplied with an ample supply of finished parts of the proper quality.

101. In a large assembling department, however, it is very necessary that you have an adequate stock tracing department for the work of one assembling division will depend upon the output of the previous assembling division and it is of the greatest importance that the different subdivisions in an assembling room be watched carefully at all times to see that their output is kept up to the required standard, or, if it is below the required standard, ascertain to the cause of the difficulty.

102. The stock tracing department should be responsible for the supplying of each assembling division with the proper number of parts and the proper small tools and equipment to do their work.

Schedules of Necessary Production

103. SCHEDULES OF STANDARD PERFORMANCES MUST BE *fixed up*

for each foreman of a sub-assembly AND EACH ONE MUST BE WATCHED WITH THE GREATEST OF CARE TO SEE THAT THIS STANDARD IS MAINTAINED.

104. The variety of assembling methods is so varied that it is impossible to suggest any particular form and I am sure that the explanation given covering stock tracing in the manufacturing division, will make it possible for you to make up forms that will prove effective.

Study of Parts

105. In considering the control of the flow of parts through the shop, one of the first things that must be done is to secure proper information concerning each part as follows:

1. Sequence of operations;
2. The departments in which these operations are performed;
3. The character and number of the machine tools—upon which the work is done;
4. The types and numbers of the jigs, fixtures that are to be used;
5. The type and numbers of the perishable tools used.

106. This action is necessary whether you are just organizing, or if you are reorganizing an old shop. The stock tracing department must be kept in the closest possible touch with the routing and any changes from the standard routing must be taken up with them. It will often be found that sequence of operations are changed in such a manner as to be very confusing to the stock routing and tracing department, and they must have accurate information about all changes, in order that they may guide their work properly.

Classify Parts in Two Sections

107. After the stock tracing department has secured this information, it will usually be found very useful for them to consider carefully the character of the work performed on all these parts and divide them in to several groups, these groups depending upon the difficulties to be encountered in getting the parts through the shop.

Section Dealing with Simple Operations

108. On such parts as require simple operations, there is very little work to be done, as the parts usually come through in large

quantities, and the operations of the system in the finished stores will easily take care of these or similar situations.

Section Dealing with Difficult Operations. The Very First Step

109. The parts which are more complicated and require a greater number of operations and more difficult ones to get through, deserve especial consideration and a careful survey of these will pay for itself many times over. You must consider that it is these more complex parts upon which the delays and greater cost occur and therefore, a careful investigation of each of them will pay. THIS SHOULD BE UNDERTAKEN BY THE SUPERINTENDENT WITH THE CHIEF ENGINEER, THE HEAD TOOL DESIGNER, TOOL ROOM FOREMEN, HEAD OF STOCK TRACING, CHIEF INSPECTOR, CHIEF PRODUCTION FOREMEN AND SHOULD COVER:

The Survey

A. The character and nature of materials. Can these be changed and if so, what should the changes be in order to insure a better flow of production.

B. Limits and tolerances. Can these be altered so as to lessen the cost and quicken the manufacture without impairing quality? Sometimes tolerances that are unnecessarily close are insisted upon, this condition affecting adversely the production of important parts.

C. Are the machine tools and special tools of the best type required for the various operations? Often the purchase of a new or different type of machine tool will increase production materially and pay for itself many times over.

D. Is the tooling of such design and of such strength as to permit of the highest possible quantity production? Nothing is more useful than a survey of the tooling on these jobs. Bad tooling is responsible for many an output shortage.

E. Is the tooling such as to require a high grade high-priced operator and can it be changed so as to make possible the use of a lower grade operator?

F. Is it certain that the machine tools as well as the tooling are ample in quantity in order to give the required output? This is an important consideration.

G. Is the routing of operations the best that can be devised?

If any change is desirable, will the cost and the probable necessary changes in tooling be too great to justify it?

110. Very often when investigations of this character are started the mistake is made in attempting to do too much. The number of parts are usually so great and the amount of data is so voluminous that often the work is so bewildering that it is seldom carried through to a successful issue. However, by using a little common sense, the separating and classifying of parts into (*a*) the parts that are simple to manufacture, and (*b*) the parts that are difficult to manufacture, a very quick and effective way to get quick results can be found as outlined above. Naturally, the chief concentration should be made on those parts which are difficult to bring through and rich and immediate results will be gotten from this course.

111. Of course, the engineer or the designing department is supposed to have determined the proper sequence of operations of parts through the shop and to have designed their tools to meet this condition. Often, however, the production department finds that the sequence of operations can be changed to the very material advantage of their production and where this is found possible, such changes should be made in case the cost of the tooling and the changes thereof are not too great. HOWEVER, LET ME CAUTION YOU FROM ATTEMPTING ANY CHANGES IN THE SEQUENCE OF OPERATIONS UNTIL YOU HAVE CONFERRED WITH THE HEADS OF ALL DEPARTMENTS CONCERNED. IF YOU ONCE DECIDE UPON A CHANGE, THEN UNDER NO CONDITIONS ORDER THE CHANGE MADE UNTIL ALL OF THE NEW TOOLS HAVE COME INTO THE SHOP AND *have been tried out.* IN THIS WAY MUCH TROUBLE CAN BE AVOIDED.

HANDLING OF PARTS THROUGH THE SHOP

112. Excellent results can always be secured by having a committee make a special study of the handling of parts throughout all of the shop processes. The questions involved are:

A. How shall stock be moved.
B. Under whose control shall this movement be;
C. Where shall the stock be placed when it is delivered to a department;
D. How shall the stock moving department be notified when the material is ready to be moved.

113. These are simple matters and are so dependent upon shop

conditions that each shop must settle these points according to the shop conditions.

Departmental Stock Platforms

114. It is, however, important to note that materials *which are not being worked upon* should not be allowed to lie around on the floor in any particular department for this results not only in confusion and congestion, but also makes it difficult to find material when it is required. It also makes it hard for a foreman to tell what he really has in his department.

115. Whenever it is possible, one convenient spot should be selected in each department and a platform placed at this spot of sufficient height so as to make it easy to remove the parts from the trucks.

116. One end of this platform should be used for incoming parts and the other end for work which has been finished and is to be delivered to other departments. All boxes of parts from other departments should be brought to this point and loaded upon the incoming end of the platform. Just previous to the time the work is needed by the workmen, the parts are removed from this platform and delivered to the proper worker. The finished parts are removed from the floors and placed upon the outgoing end of the platform in order that they may be easily selected by the truckers for IMMEDIATE REMOVAL to the ingoing section of the next department's platform. SUCH AN ARRANGEMENT IS VERY EFFECTIVE AND MAKES IT POSSIBLE FOR THE SUPERINTENDENT OR FOREMAN HIMSELF TO ALWAYS TELL AT A GLANCE JUST HOW MUCH MATERIAL EACH PARTICULAR DEPARTMENT HAS TO WORK UPON.

Visual Evidence of Stock Conditions

117. If they *see* that the number of boxes of parts are running low, they can then get after the stock tracing department to get through enough materials from other departments to keep his department busy, or if they find that this cannot be done, they can then arrange to lay off the workers and not have them standing around idle.

118. If, on the other hand, he finds that the number of boxes or trays are running well above the average he can then request the superintendent for permission to work overtime in order to clean up the situation and keep the departments that follow him busy.

119. The importance of this simple scheme is greater than it appears upon the surface for in the ordinary large department the foreman does not and cannot know what he has charged against him. It is often very difficult for him to determine how to operate his department most efficiently unless he is guided by some such method.

120. I have always found that this VISUAL EVIDENCE OF THIS STOCK CONDITION MAKES A STRONG IMPRESSION ON THE FOREMAN. Again, too, a casual look at his foremen's stock platforms tells the story to the superintendent that is beyond contradiction.

121. In addition to this it is a great advantage to keep off the factory floors all boxes or trays that are not being operated upon as this simplifies the work of the stock tracing department greatly and also makes inventories much more simple.

Machinery and Output Survey

122. When, owing to serious shop delays, it becomes necessary to make a really thorough survey of the situation relating to the movement and storing of parts, it is important that accurate knowledge be acquired concerning the machinery and equipment in order that the management can ascertain exactly how these conditions are matched up with the output requirements. In other words, this survey will show the management whether or not his machinery and tooling equipment is properly balanced in order that he may get out the necessary output. The manager who goes into this question thoroughly is going to meet with some surprises for usually the actual amount of the different tools on hand together with their tooling do not properly match up with the output requirements.

Serious Delays Often Caused by Continual Shortage of Only a Few Parts

123. It is astonishing to find how often the output on an important product in the assembling room will be continually delayed because of the shortage of two or three parts which upon investigation is found to be due to lack of sufficient machine tools or other equipment.

124. When the machinery was originally ordered the quantities required were, of course, based upon estimates, but as the tooling has been improved and the operators have gained their skill the output on one set of machines will increase far beyond the output of machines on which perhaps greater exactitude is re-

quired. This usually results in a surprising lack of balance in a shop equipment as compared to output requirements and leads to very inefficient conditions when the demand for greater output arises.

125. One of the first things that I do when going into the reorganizing of a shop, is to make this investigation and survey of machinery, equipment and tools as compared to output requirements. The listing up of machinery and equipment in accordance with the methods advocated will show clearly just where the *over-supply* and *under-supply* of machinery, equipment and tooling exists. As stated previously, there are always found quantities of machinery for which there is practically little or no use and, on the other

MACHINE TOOL SURVEY

DATE ....

NAME OF PART .... PRODUCT ....

DAILY OR WEEKLY OUTPUT – NO. OF PARTS ....

OPERATIONS	DEPTS.	TYPE OF MACHINE TOOL	STANDARD HOURLY OUTPUT	OUTPUT REQUIRED	NUMBER OF MACHINE TOOLS REQUIRED	NUMBER OF MACHINE TOOLS ON HAND	EXCESS	SHORTAGE	

FIGURE 17.—Form for Machine Tool Survey, Refer to Paragraph 125

hand, many important operations that are under-supplied in machinery and equipment, thus making it necessary for these particular machines to work overtime if delays are to be avoided.

126. This suggested survey will point out the weak points and will enable a concern to take steps to supply the machinery and tooling where it is needed and, if they think it is wise, then to dispose of the over-supply of machinery that is not needed. The form Figure 17 is self-explanatory:

MACHINERY AND OUTPUT RECORD

127. It will be noted that I have taken each part, and, in Column 1 Have listed up the operations;

Column 2 Have listed up the department in which the operation is performed;

Column 3 Type of machine tool;

Column 4 Standard hourly output as determined by experiment (described in Chapters V to XI);

Column 5 Output required. It is important to note that this output required must take account of the scrappage which of course varies with each particular operation, and which must be taken into consideration;

Column 6 The number of machine tools required, which of course, is obtained by dividing the hourly output required by the standard hourly output which should be secured;

TOOL SURVEY

DATE ....

PRODUCT ....

NAME OF PART ....

DAILY OR WEEKLY OUTPUT-NO. OF PARTS ....

OPERATIONS	DEPTS.	TYPE OF TOOL	STANDARD HOURLY OUTPUT	OUTPUT REQUIRED	NUMBER OF TOOLS REQUIRED	NUMBER OF TOOLS ON HAND	EXCESS	SHORTAGE	

FIGURE 18.—Form for Summary Tool Survey, Refer to Paragraph 130

Column 7 The number of machine tools on hand;

Column 8 Excess machines on hand;

Column 9 Shortage of machines.

128. Then the total number of machine tools required is determined by adding together the number of machine tools required for the production of all the necessary numbers of parts on all operations. Care should be taken to note that the figures showing machine tools required on operations will result in fractional figures, and when adding them up, allowance must be made for this. Also allowance must be made for time lost in necessary set-up of jobs.

129. It will therefore be seen that this immediately gives a clear exposition of the situation in regard to machine tools in the shop.

It also indicates clearly those operations upon which the machine-tool equipment is weak, and shows the management where additional machine tools should be purchased. It also indicates just the operations which should work overtime, while new equipment is being secured.

Survey of Tools and Fixtures

130. The same type of surveys must be made on tools and fixtures for it is very often found, while the machine-tool equipment may be adequate, there is not a sufficient supply of jigs, fixtures, etc., on hand to get the required output. Oftentimes this is due to the fact that the tools are so constructed as to need more than their share of repairing, and consequently, they are out of commission so long a time as to cripple the output. Figure 18 will indicate this condition:

131. As stated previously, I consider this survey as of first importance. If can be done very quickly and its value in showing up the weak points in the shop equipment is inestimable, for it indicates to the management and the stock tracing department just where they may expect to have trouble and so enables them to concentrate their attention upon these spots. I have often found it effective to group all of these bad spots into several classifications and then put special stock tracing men upon them, to see that everything possible was done to move the parts from one point to another, and push them to a limit day and night, all of this bringing excellent results.

Arrangement of Machinery

132. I quite appreciate the fact that ordinarily it is impossible for a manufacturer to consider ripping up his present machinery and rearranging it, but I do wish to bring out the fact that there is no one thing in shop management that will bring such immediate results as a proper rearrangement of machinery. There is certainly nothing that will simplify the stock routing and stock tracing as much as this. Select any particular product and divide the operations into:

A. The big important parts;

B. The smaller and less important parts;

C. Then lay out the shop machinery, bench work, inspection and all other operations for each part so that the operations on each will follow one another in sequence. Each

important part will then have a line of machine tools, inspection, bench work, wash, grinding, etc., of its own.

D. The machinery arrangement on the smaller jobs can usually be in groups.

133. With such arrangement, your troubles with stock routing and tracing and delayed machining will disappear. In addition to this, there is also a large reduction in the amount of working capital to be tied up in parts that are in process of manufacture.

134. If you have any doubts of the advisability of considering this, get a blue print layout of your shop arrangement, and have a draftsman draw lines, showing the lines of travel of a few of your important parts as they pursue their uncertain way through your shop. The figures will surprise you and prove my contention as to the advantages of a proper arrangement of machinery. In one large shop I found that these main parts were traveling on an average 2980 feet in order to get 400 feet across the shop. By a rearrangement of machinery that was accomplished on two Saturday afternoons and Sundays, I cut this travel down to 520 feet and best of all, I thus managed to get those parts with which we were continually having trouble, lined up one operation after another, so that at any moment, we could note the production situation. Our difficulties disappeared at once.

135. As stated before, however, this is rather a large undertaking, and should be gone at in a slow and careful manner, and any stock routing and tracing systems to be introduced should not be held up awaiting consummation of any such plans. I will deal with this question more fully in following chapters.

CHAPTER V

DETERMINATION OF STANDARDS

The Attitude of Labor and of the Employee—The Reasons—The Importance of "Standard Hourly Outputs"—THE BIG PRINCIPLE

1. GLOSS over it as we may, the antagonism that lies at the bottom of the relationship between capital and labor is a menace to efficient industry. It has always appeared to me that there has never been a recognition of the real reason for this volcano-like situation. Each side attends conventions and banquets and listens to address after address upon the beauties of "co-operation between capital and labor." They applaud, but "with their tongues in their cheeks." Both sides know that, in the average American shop, conditions exist which make real co-operative effort well nigh impossible.

2. Fair speech alone never cures an unjust condition. It takes ACTION. Action to ferret out the faults—action to remedy them. Action based on fair play—justice on both sides.

THE DISSATISFIED WORKER

3. We may institute hospitals, sanitary conditions, schools, the best of welfare work, but all these count but little to a group of employees bitterly dissatisfied with their system of pay, which may be based upon the principle of arbitrarily reducing rates when a workman earns, what to the employer, seems too large a sum, or with a method of unjust discharges, or with a method of promotion based not upon efficiency and fairness but upon favoritism.

THE DISSATISFIED EMPLOYER

4. On the other hand, the employer has real reason for a similar discontent with his workmen, especially when he once finds out through the knowledge that comes from modern production methods that his workers for years have been giving him only 50% of a fair day's output. An employer under such conditions

is not in a frame of mind to adopt soft methods in dealing with the situation.

The Outcry Against the Workman

5. For some years the cry was heard against the employee for his "restriction of output." Millions of words were printed proving to the worker that such restrictions were socially and economically wrong and he must quit such practices. Naturally, the employers were not slow in joining this chorus. All the while the workers simply smiled and went their way, restricting output still because they all knew that this lifting of the lid of restriction, this increase of output, always leads to increased earning with the unhappy result of the employer promptly reducing their rates on the jobs (be it piece work, bonus or premium), and they finding themselves at the end of a month working much harder and making no more money than they did formerly. Therefore, they made no effort to cut loose and give the employer or the community the full benefit of their capacity for output. This is quite natural under the conditions and undoubtedly, most of us would act in the same manner.

The Outcry Against the Employer

6. At the present time the political economist and the professional writer have a new vision and, seeing the worker in this new light, have turned their batteries upon the employer and are now sending up chorus after chorus over his "iniquities in ruthlessly cutting prices."

7. Now, let us put ourselves in the employer's place and see if we would act differently. The examples of conditions cited below are actual ones and are a fair illustration of the usual conditions.

8. A concern had an annual payroll of slightly over $200,000. The manager and part owner had been spending most of his waking moments wondering how he could meet the oncoming payrolls, or meet his banking obligations, or pay pressing bills.

9. Our friends in the fields of labor or of statemanship may rest assured that this condition is not at all unusual, notwithstanding their theories that every manufacturer *must* be a millionaire.

10. This man got a good production man on the job and they quietly made their "time studies" on a large number of typical cases. Their tests showed that the workmen, by making even an ordinary effort to get out a fair day's production could easily increase the output 50%. A little figuring showed him that if he cut his

piece-work rates so as to get the benefit of this discovery (i.e. $33^1/_3\%$), his workmen could still make the same amount of money they did before and not over-exert themselves. He would gain over $66,000 immediately which would be enough to put him on his feet and earn a dividend.

11. What would you do under such conditions? Probably as he did—angry at his discovery of the manner in which his workers had imposed upon him, he arbitrarily cut the price—without bothering to explain the situation to the men, gained his $66,000 per year, and sewed the seeds for future labor troubles.

The Unwritten Law of the Worker

12. There is an unwritten law amongst the shop workers that the output per hour on each job shall not exceed a certain amount. This condition exists in shops that are either "union" or "open," and woe betide the ambitious and forceful workman who cuts loose and discloses the possibility of production. This applies with particular force to those shops upon which the work is being done by the day-work system of pay.

13. We must not forget that the worker in the usual shop is not a bit interested in your costs or your troubles. He cares for his wages as you care for your profits and he does not feel that it is to his interest to aid anyone in setting prices. Therefore, he will almost invariably lay down on a day-work job in order to get as good a price or rate of pay as possible when the job is put upon piece work, premium or bonus.

14. Naturally, after the rate is once set and when a predetermined output is reached, they will not exceed this output if they have any reason to fear any reduction in prices as a consequence.

What the Workmen Fear

15. The employer, when he begins his try-outs and setting of prices, is liable to go to the other extreme. Sometimes, if he does set his prices upon a basis of results from actual tests, the man he selects for trying out these jobs is a fast worker—the time the trial lasts is usually short, consequently, he makes the mistake of using this ascertained output as the basis for his rate of pay, and the results are that the workers are obliged to speed up to too high a point in order to make their proper day's pay.

16. This is one of the principal reasons for the workmen's hostility to "time studies" or "try-outs"; this having gone so far as

to lead to an enactment of official legislation forbidding such important and necessary methods in the work done for the United States Navy.

17. A senator, to whom I wrote a letter of protest, replied that such legislation was necessary to prevent the employer from "exploiting the American workingman through the use of a pace maker." This was a striking statement in as much as the American workmen that I had in mind were certainly "exploiting" a particular shop on a cost-plus contract by working at less than 50% efficiency.

18. This legislation and likewise the letter gives the American manufacturer clear warning that all methods used by him in time study or try-out work must be fair in character in order to avoid the charge of "pace making and exploitation."

19. A few stories of actual occurrences will help to illustrate the conditions.

From Actual Experience

20. In one shop I placed a friend of mine who was an expert workman in the machining department with the understanding that he was to cut loose on some of the important jobs. He started in on one part 4 C B, upon which the average production had been seventeen (17) per hour. Without the slightest trouble he was soon up to a production of thirty-two (32) an hour—it was afterwards proved that the job should be producing forty-two (42) an hour. No sooner had he reached the thirty (30)-an-hour production than he was waited on by a committee of three workmen. The situation being carefully watched, it was observed that two of these men engaged the operator's attention in strenuous conversation about this increase in output—the third quietly altering the stops on the machine, being unobserved by the operator, it being their intention to get him discharged for bad work if possible. The two men asked the operator what he meant by "trying to kill the job," "if he was one of those infernal pace makers," and then told him that if he would continue this practice they would combine to get him out of the shop.

21. In another case I was having some tests for standard hourly outputs made in a private room upon a floor above the machine room. Just before noon two men slipped up from the machine room, unobserved, entered this private room and observed the workers I had in there closely enough so that they could recognize

them when the shop closed. At the noon hour my two men were surrounded by a large group of the operators who delivered their opinions of such work in language more forceful than polite, interjecting threats so strong that these men concluded that they would have nothing further to do with the work.

22. In another case a conscientious workman upon starting work in a shop was told by his shop mates that he could not go beyond twenty-two (22) pieces per hour upon a certain part. This proved to be a hard task for him for he found that he could produce forty (40) without any extra effort. As a matter of fact the bonus figures later put on this job were based upon an output of 55 per hour, which was found to be reasonable.

23. Some years ago I made tests in a finely organized shop supposed to be a "top notcher" in efficiency. The first question I asked related to their method of setting piece-work prices. I ascertained that these prices had originally been set years ago by taking the output they had secured under day work increasing this output 20% and then using these figures as a basis for setting the piece-work price. Of course, a foundation of this character was of the very worst. This increase should have been nearer 100% than 20% and, consequently, this low estimate of output was the cause of continuous trouble. This condition led to:

1st. Excessive earnings by the workmen;
2d. The prompt cutting of prices by the foremen;
3d. Finally a complete system of restriction of output by the workmen due to their fears of these cuts of piece-work prices.

24. Upon an investigation I made in the assembly department using a worker whom I trained especially for the job, I found 286 jobs upon which the prices should have been not over 40% of what they actually were. In another department employing 125 men I found that it would be possible for the workers to increase their output over double and then not overwork themselves.

25. In another large shop employing 8600 people operating on day work, it was found possible to increase the output on the average with the same machines and operators over double their former output.

The Workman Knows the Art of Camouflage

26. These figures are all very surprising and Mr. Manager or Mr. Superintendent will say, "that is all very well; those shops were

in bad shape, but it is not the condition in my shop—just walk out and see how busy they are." Do not fool yourself, Mr. Manager or Mr. Superintendent. Your workmen learned the real art of camouflage long years before we or they understood the real meaning of the word. They have down to a science the art of seeming to work and yet accomplishing but little, and it takes a very good man to catch them at this. Production experts of high reputation agree that this condition of "under-efficiency" in American shops is general.

Fear of Exploitation

27. This situation in regard to employer and employee arises from the fact that both fear "exploitation" by the other, and this fear of exploitation arises from the fact that both sides have been and are actually exploiting the other in the manner shown.

How This Condition Has Arisen

28. Bad methods of setting rates (piece work, bonus or premium) account for the largest part of this trouble. When new rates are set upon the basis of the output secured under day work, incorrect results are certain to follow, as the basis is in itself so incorrect.

29. The method of having the superintendents and foremen "estimate" or rather guess the probable rates is likewise bad. I will later show examples illustrating how defective their judgment usually is.

30. In either case the prices set are so high that invariably the worker by extending himself may earn more than might be considered a fair day's earnings. The prices will be promptly cut—either because the firm's policy is against such excessive earnings or the superintendent or foremen do not want the management to know how incorrect their estimates have been. The worker thus receives his lesson in shop economics which he never forgets.

Is There a Remedy for This Situation?

31. The situation is one of conflicting interests where the stronger wins, at least temporarily. The trouble is intensified by the fact that both sides have a large degree of justice on their sides and each does not recognize the injustice of their own positions because the situation is so clouded by lack of knowledge of the

true situation—misinformation concerning it—and strong self-interest.

32. The facts are:

1. It is wrong for a worker to restrict output, but he will do it if his employer cuts his prices.
2. It is wrong for an employer to reduce prices because a workman earns more than he thinks he should, but he will do it if the earnings are beyond reason.
3. An industry cannot withstand competition, it cannot be fair to its stockholders, nor can it make a fair price to the people if wages paid for the character and amount of work done is outrageously exorbitant.

33. Therefore prices that are based upon incorrect hourly output standards, and are therefore too high, are wrong.

Conclusion

34. The conclusions must be that:

(1) The "standard hourly outputs" must be set *right*. This should make the worker's rate such that he can earn a good day's pay for normal exertion, while the more active workman can make a high rate of pay.

(2) There can be no changing of rates when once determined and set.

(3) There can be no restriction in output.

35. If the "standard hourly outputs" are once properly determined and the rates set accordingly, then the employer will not cut his prices, nor will the workers restrict their output. Therefore:

The Big Principle

THE ONE BIG PRINCIPLE IS: "THE CORRECT DETERMINATION BY ACTUAL AND FAIR TESTS OF THE PROPER 'STANDARD HOURLY OUTPUTS' THAT A MANUFACTURER HAS A RIGHT TO EXPECT FROM EACH MACHINE, EACH BENCH MAN, EACH ASSEMBLER, EACH OPERATOR." SETTING THESE STANDARDS, NOT AT A PACE-MAKER'S SCHEDULE, BUT UPON SUCH A BASIS AS WILL ENABLE THE AVERAGE WORKER, WORKING AT A NORMAL SPEED, TO EARN A FAIR WAGE, ALL WITH THE DISTINCT AGREEMENT THAT ONCE SET THE RATE WILL NOT BE CHANGED UNLESS THE METHODS ARE ALTERED.

CHAPTER VI

PRINCIPLE NUMBER TWO: "THE KNOWLEDGE OF WHAT *SHOULD* BE PRODUCED BY WORKMEN AND MACHINE TOOLS AND WHAT *SHOULD* BE DONE BY EACH AND EVERY DEPARTMENT."

1. I PROPOSE to show common-sense methods by which these "best possible outputs" can be determined accurately and quickly. Methods that have proven their worth in actual use in many shops. These results I call "THE STANDARD HOURLY OUTPUTS."

2. In all of factory management there is nothing more important than for the manufacturer TO KNOW WHAT OUTPUT HE HAS THE RIGHT TO EXPECT FROM EVERY MACHINE TOOL AND OFF OF EVERY TOOL IN HIS SHOP. Any man with sense will say "yes" to this proposition. Yet, the real factory managers of this country know that in the average American factory the management does NOT know these vital facts: That the outputs upon which wages are based were *not* calculated properly; that they are *far too low*; that the usual basis by which these outputs were calculated were wrong; all leading to low production, high cost, shrinkage of profits and a continuous strife between management and workmen.

3. A man with a small shop very soon recognizes the fact that his success depends upon his getting a proper output from each operator and each machine, and you may be sure that he will see to it that he gets it. When such a shop increases from a few employees to hundreds and then to thousands, it is evident that it is of equal importance that he secure a proper output from each operator and each machine. The questions, however, are:

1. How to determine what these outputs should be, and
2. How to introduce them without friction.

4. In the ordinary shop when the piece work, bonus or premium is started, the employer usually makes a serious error of basing his preliminary prices upon his former day-work records, making some allowance for probable increase of output in establishing standards. However, this allowance is usually far below the proper

figures. Then, after he has adopted this method for his preliminary establishment of prices, he usually depends upon his superintendents and foremen to set his prices thereafter. Experience has proven that there is no more dangerous procedure than trusting to your foremens' *estimates* in determining standard outputs for, while these men may be able to determine the best method of turning out an output, they are very seldom good judges of what the *standard* output should be. They usually will not take the time nor, indeed, have they the training to make a real analytical study of the proposition and their estimates and guesses are sure to be grossly incorrect.

5. When you consider that this condition leads to the wage disputes that are usually so serious, and that this output of each machine and each operator is the determining factor not only of your volume of output but also of its costs, you can see what I am driving at when I insist again and again that accurate determination of standard hourly output is absolutely vital.

6. The problem of the determination of standard hourly outputs may be divided into four sections.

7. 1st. WHERE SHALL THEY BE MADE? We shall deal with the problem of where these tests shall be made; that is, shall they be made in a separate room or in the shop, and if made in the shop shall they be made during working hours or after working hours?

8. 2nd. HOW SHALL THEY BE MADE? Shall the tests be performed by an expert selected for this particular work who is to do nothing else or shall the work be done in the shop by a workman under observation by a "time study man holding a stop watch?"

9. 3rd. HOW SHALL THE JOBS BE CLASSIFIED SO AS TO EXPEDITE THE MAKING OF OUTPUT STUDIES? Shall the parts be taken singly and the standard hourly output be determined operation by operation or shall the parts be classified and grouped so that after a determination of the standard hourly output on a few of them, the proper output on the balance may be arrived at by calculating from these results without losing time in making comprehensive tests.

10. 4th. HOW TO MAKE THESE TESTS. The questions here will deal with the problems of the best methods of conducting the tests both for "set ups" and also the actual time required for the job, this being done by a standardized method.

DISCUSSION OF THESE FOUR DIVISIONS

11. (1) WHERE SHALL TESTS BE MADE. The worst place for

such studies is in the shop itself during working hours. The operators feel a strong hostility to this class of work and will bring to bear upon the man doing the testing all possible influences to force him to deceive the time study man and make his output as low as may be possible. As already brought out in the previous section, they will combine amongst themselves to exert this influence regardless of whether this shop is "union" or "open." They will watch the proceedings in the closest manner possible. If they learn that your methods are such as to lead to gross *under* estimates they pay little attention to the work for they will feel satisfied that the rate established upon such outputs will be high.

The Hostility of This Shop

12. However, if they suspect that your studies reveal the real possibilities of output, trouble usually begins to loom up immediately and the more radical of the working men soon begin to raise a storm.

13. A first-class time study man who is willing to work in the interest of the company will, when he is doing the work in the shop, be subjected to both hostility and strong though covert influences on the part of his fellow workmen to consume more time than he should. It is this influence that makes it absurd to depend upon the results of time and output studies when done in the shop during working hours, especially when they are conducted by men who are not expert mechanics.

14. To expect the operator, watched covertly by all the eyes in the vicinity, hearing strong warnings growled at him as men pass him by on pretended errands, to expect this man to do his best for the company is to expect too much from human nature.

15. If the machinery cannot be moved to a separate testing department at least temporarily, then these tests should be conducted at times when the shop is not operating.

The Production of the Plant Depends Upon Getting the Full Production Out of Each Machine

16. By far the best plan is to have a separate room in which these tests are to be conducted. If the machinery involved is light in character it should be moved to this room and the tests conducted under conditions of the greatest privacy. It must not be forgotten that the production of the plant depends upon the output from the dif-

ferent machines and that the output from these different machines will depend upon the results of these studies of the standard hourly output and it, therefore, is well worth while to spend the few dollars necessary to move the machinery into a private room where the tests can be conducted under proper conditions.

17. If the conditions under which tests are made are wrong it is not at all difficult to make an error in the studies which will amount to at least 15 per cent and a 15 per cent difference in your payroll will mean a big item in your costs.

The Way to Do It

18. The removal of machines from the shop to these rooms can be made a small matter if all arrangements are made properly. Just recently we had a large number of milling-machine operations upon which we wished to determine standard hourly outputs. We moved two milling machines up to our testing rooms and in ten days we had sufficient data to set over 200 standard hourly outputs. We then sent the mills back to the shop and brought in lathes and went through the same process. In two weeks' time we established the standard hourly rates on 260 jobs and we then sent the lathes back to the shop.

19. Inasmuch as these studies showed that production could be increased over 80% (which is quite usual), the moving of these machines was indeed a small matter compared to the tremendously favorable results secured later from these studies.

20. How shall they be made? As stated in a previous chapter the tests must be made by a special test man selected for this work. Guesses or estimates of foremen or of superintendents must be *absolutely prohibited.*

21. The tester must be a good mechanic and a fast worker. Right here I emphasize strongly the fact that too often the wrong type of man is selected for these determinations. Case after case have I seen of the most ridiculous selection; men of very little experience as mechanics picked out to watch over an expert worker, holding a stop watch on the man and turning in results that are worse than useless and that would, sooner or later, do great harm.

22. This determination of standard output is a regular *"he man's job,"* and no inexperienced, timid-hearted man or college youth has either the grit or the knowledge to enable him to do the job right.

23. Therefore, your "output study man" must be, as stated be-

fore, a natural mechanic and a naturally fast worker whether he is going to do the work himself or be an observer of any worker who will try out the job. Such a man must have knowledge and ability enough to see if the operator is "stalling" or taking more time than he should. He must be able to understand the existing tables of feeds, speeds, and depths of cuts on different metals and apply these tables to his problems. He must have mechanical skill enough to "set up" the jobs himself in order to determine the set-up times and to standardize them. He must have had enough experience in handling parts so that he can suggest ways and means of quickening such handling. He must be smart, quick witted and ambitious, and above all, must be one who, after you place him on the job, will not be influenced by his old associations and influences, all of which may tend to make him too liberal in determining standard hourly outputs.

24. MAKE HIM A FOREMAN. In order to meet this condition I have always found it advisable to give this man the title of foreman and put him on straight time. This one thing alone will tend to do more than anything else to remove him from the influences of his former associates.

"COMMITTEES"

25. Do not leave this work up to your output study man alone. When the more important studies and tests are being made I always make it my business to be present myself together with my superintendents of production, assembly, engineering (including tool room), inspection and costs. We also add the foreman of the job under test. This committee studies the features of each problem together with the output study man. By the time this body of men have considered the best methods of handling parts, or setting up of jobs, the existing method of doing the work, and the best methods of tooling, we may feel certain that these jobs are thoroughly analyzed.

26. I cannot emphasize too strongly the importance of having such a group of men present, certainly during the most important tests, for by doing this you get the benefit of their wide experience and their keen minds. And again, after they have taken a share in this work you may feel certain that when the jobs are started through the shop with these studies as a basis, the entire proposition will get their hearty support. Then, too, the presence of these men has a very good influence on the output study man for he naturally

will want to do his best when watched by all of these men and you will thus be certain of a satisfactory trial.

27. In case their arises any shop disputes as a result of putting these output studies into effect, it will be settled very quickly inasmuch as the superintendents have had a share in determining these outputs.

28. (3) HOW SHALL THE JOBS BE CLASSIFIED SO AS TO EXPEDITE THE MAKING OF OUTPUT STUDIES. Whenever this question of "determination of output" is discussed with an old-time superintendent or foreman, he usually comments forcefully upon the great number of parts and vast number of operations that he and his organization have to handle, and brings out the impossibility of making output studies on each and all of such operations.

29. The time that is consumed ordinarily in making standard hourly output studies on each part (operation by operation) is usually so great as to make it seem almost impossible to make similar studies on each and every item of the products manufactured. This conception of the length of time required often leads to the "guessing" done on setting prices, for the average production man will consider it impossible to test all operations.

THEORY VERSUS PRACTICE

30. At this point is where fine-spun theory and actual practice often have to part company. It is all very well for the production expert to insist upon detailed output studies upon each operation on every part, attempting to get each of the moves down to a fraction of a second, but the difficulty is that in the average shop the management cannot wait for this work to be too long drawn out. They've simply got to get action. In order to get quick and at the same time safe results I have found the following plan to be safe, thorough and certainly speedy.

THE CLASSIFICATION OF PARTS

31. The plan to be described aims to classify the different operations on all parts into groups (first separated according to metals), *according to the size and type of machine tool upon which they are to be performed.* Thus, all operations on No. 2 Milwaukee Mills are in one group, all on the 14-in. lathes on another, all on the 100-ton hydraulic presses on another, etc.

32. Then there are selected a number of these operations from any one group which may be considered as typical of this group.

The output study is then made on each of these representative operations and *from the results obtained* on these operations, calculations are made which will give an accurate estimated standard hourly output on the *balance of each group.*

33. As an example we have proven that ten tests would be thoroughly respresentative of similar operations performed on 150 different parts and thus we are able to *set 150 standard hourly outputs* by making *proper deductions from these ten tests.*

34. The procedure is as follows:

(1) Divide all of the parts entering into your products into classes according to metals, that is, the cast-iron parts should be in one group, cold rolled in another, steel forgings in another, brass castings in another, etc.

(2) These parts may be further sub-divided into groups according to their size if this is considered desirable, although in many cases this is not necessary.

(3) Then take each part, *list up the operations and show the size and type of machine tool upon which each operation is performed.*

4. The final and important step is then to make a re-classification of all of these parts *according to the type and size of machine tool.* As an example, one of these machine tools might be a 14-in. lathe. Under this classification of "14-in. lathes" would be listed up all of the operations (giving the number or name of operation), and the parts upon which the operation were performed.

35. The same procedure will be performed on milling machines, shapers, planers, etc.

36. Thus, by looking at the list on milling machines you will see immediately *all of* the operations performed on *this* type of machine tool.

An Example

37. In one large factory under my management we have parts involving the use of cast iron, cast steel, machine steel, high-carbon steel, steel forgings, brass rod, sheet brass, brass castings, aluminum forgings, aluminum castings, German silver, gun metal and Tobin bronze. We had machine operations involving the use of hand-screw machines, automatic screw machines, punch presses, hydraulic presses, milling machines of all types, thread millers, large and small lathes including bench lathes for precision grinders and polishing machines for lenses and prisms.

38. There were a large number of parts, some of them involving over 50 separate operations. The work was of a close character.

39. This condition was rapidly handled in the manner indicated, i. e., I first formed a committee of my superintendents, as already indicated, which committee was to consider the problem and lay out a course of action.

Second, we divided the parts into groups according to the metals.

Third, we took each part and listed up the operations and indicated the type of machine tool required.

Fourth, we re-classified these into groups according to the type and size of machine tool used.

40. A form used for this purpose of classification of jobs whereby the various parts are listed, and the type and size of machine tool on which they are to be produced is also indicated, is illustrated in Figure 19.

CLASSIFICATION OF JOBS DATE..................

METAL..................................

PART	MACHINE TOOLS - TYPE & SIZE								
	10" LATHE	14" LATHE	NO. 2 CINN. MILL	NO. 3 MILL	NO. 8 VERT. MILL	NO. 2 W. & S. HAND TURRET SCR. MACH.	BORING MILL	DRILL PRESS	
AH46		2-5	1-3	4					
BH63			2-5			1-4		3-6	
KO84		1-3		2-4					
LK18		4-		2-3			1-	5	
GM24			1-2-	7	3-6			4-5	

FIGURE 19.—Form Used for the Classification of Jobs, Refer to Paragraph 140

41. This committee, by giving careful consideration to the machine tools and operations thereon, were able to make such a subdivision of parts (classified under each machine tool) that it would be possible to make representative tests on a small number of parts and from these tests make deductions which enabled us to rapidly determine the standard hourly outputs on the balance of each group.

42. It was also found possible to classify the parts into groups according to the general character of the "set up of the job" so that the determination of the time required for one set up could be used as a guide for the determination of the standard time required for set up for the balance of the group.

43. It is much easier to consider and settle the problems of standard hourly output for one *large number of operations classified into a group* according to machines than it is to take each separate part, try to set the standard hourly output on each operation one after another, and thus practically do the same work on similar parts over and over again.

Lack of Time

44. My reason for bearing on this point so strongly is that when the average concern needs and wants this sort of a dose of medicine it cannot afford to allow too much time and money to be spent in laborious time studies. The work must be done correctly, of course, but, at the same time, time-saving methods must be pursued in the interests of quick results.

Greater Accuracy

45. I find, too, that such a study of similar operations in large groups will lead to more accurate results, for when a group of men are studying such operations with the knowledge that their determinations will affect perhaps 200 operations in the same group, you may feel certain that the study will be a closer and more accurate one than if they considered it as affecting but one operation.

46. After you have viewed some of these big groups that will be affected by a few studies of standard hourly output you will appreciate my reasons for insisting upon the highest possible grade man for the practical end of this work and upon the best conditions under which to do the work. It is not at all unusual for the ordinary man to be incorrect to the extent of 15% and 20% and a 15% reduction in your output is a serious matter for you to face.

The Three (3) Main Divisions of Work

47. There are three main divisions of work to be taken into account when considering the determination of standard hourly outputs.

48. First, covers that division of work in which the machining time for removal of metal is the main factor in production.

Second, covers that division in which the actual time spent in removal of metal is a much smaller factor than that of handling the part and handling the fixture or jig. This is a very large

DIVISION and does not appear to have had adequate treatment hitherto.

THIRD, covers the DIVISION—very large and important—of assembling and all bench work. These are the jobs in which the skill and dexterity of the operators are the big factors and will get special attention.

CHAPTER VII

DETERMINATION OF STANDARDS OF HOURLY OUTPUT ON JOBS REQUIRING A LONG MACHINING TIME. REMOVAL OF METAL

The Standard Rules and Tables Regulating Tools—Their Quality—Their Shape—Method of Hardening and Grinding—Tables of Cutting Speeds, Feeds and Depth of Cuts on Lathes—Milling Machines—Planers.

STANDARDS

1. THERE IS a real science of production with distinct standards, rules, tables and methods just as there is in a science of engineering.

2. In removing metal there is a best steel to use for the tool, a best shape, a scientific method of hardening, a system of grinding angles that scientific investigation and practical tests have shown to be of great value.

HIT OR MISS METHOD MUST GO

3. The usual "hit or miss" method of handling this most important question affecting the removal of metal has to be thrown aside and substituted, therefore, will have to be *the real science of production* as applied to those elements that are of such vast importance in removal of metals.

THE ATTITUDE OF THE ORGANIZATION

4. Let me state at this point that the average shop superintendent and foreman have seldom been put in a position to consider these questions in all their phases and are very liable to at first assume an attitude of hostility to any plan that tends to standardize these practices on a real scientific basis.

5. However, I have never seen them give anything but hearty co-operation after they come to fully understand how thoroughly

practical the plans are and how thoroughly sensible the methods are when developed. We must remember that, valuable as shop practice and experience undoubtedly is, still no superintendent or foreman could ever have a fraction of the splendid expensive equipment so necessary for a determination of these standards, to say nothing of taking the time involved.

6. In this work to-day any ideas based upon "what we have always done," "what my years of experience has taught me," "I know more about this than any theoretical text book written," all have to be thrown in the scrap heap.

Thousands of Experiments

7. The standards laid down here are the result of many *tens of thousands* of experiments made at great cost by special machines, special dynamometers, and other special equipment without which such valuable results could not have been secured. The men who have attained such results number Dr. Nicholson, F. W. Taylor, Professor Poliakoff, F. Dempster Smith, Professor Ripper and others.

8. I state emphatically at this point that if you and your organization are not willing to *adopt standards* and *stick to them* you might as well stop and not attempt *any* improvements. You cannot get anywhere unless you get these details *right*—keep them *right* and make them *go right.*

Tables of Best Cutting Speeds, Feeds, Depth of Cut

9. The net result of the methods to be described are the very valuable tables showing the best possible cutting speeds, feeds, depth of cut on soft, medium and hard steel and on soft, medium and hard cast iron.

10. These tables cover the data on roughing and finishing cuts on lathes, planers, milling machines.

11. Now, it is perfectly obvious that, where we have so many factors any one of which will seriously affect the possible cutting speed, feeds, depth of cut such as quality of tool steel used, methods of hardening, shape of cutting edge, lip and clearance angle, lubrication, quality of metal to be machined, allowable tolerances, character of finish desired, we simply *cannot* allow the "hit or miss" method to creep into any of these elements.

12. It is necessary then to adopt standards on quality of tool

steel, standards for forging shapes, standards for hardening, standards for shape of cutting edge, standards for lip and clearance angle and side and back slope, standards of lubrication, and standards of quality of materials used. And, best of all, these standards have all been worked out for us by these brilliant experimentors by making tens of thousands of careful tests, reaching conclusions that cannot be disputed by any man of science or any shop man.

Simple After It Is Once Started

13. The only difficulty to be met with is at the beginning; namely, the adapting of the standards given to meet your particular needs and persuading your organization to co-operate in their introduction and adhering to them. Once they are determined, the standard practice started, the great benefit felt throughout the shop, there will be no further trouble.

ROUGHING CUTS—LATHE WORK

The Tool When Removing Metal Does Not Cut It Off—It Tears It Off

14. Before starting into details, a brief study of the action of the tool upon metal when removing it and the action of the metal on the tool is necessary in order that we may clearly understand the reasons for many of the recommendations. It is a fact that the final failure of a tool—the breaking down of its cutting edge—does *not* come from actual wear on the cutting edge (except at very slow speeds), but comes from the heat generated by the friction of the chip striking the tool a short distance above the cutting edge, this heat traveling downwardly, weakening the edge and causing failure.

How the Tool Tears Away the Chip

15. After the tool is well started and the cutting speed is well up, the cutting edge of the tool does not strike the main body of the metal at all. The tool is acting as a wedge and is *tearing away* the metal in a heavy chip well in front of the true cutting edge. This chip strikes upon the tool at a spot *above* the cutting edge. There it creates so much heat through its own heat and the friction generated from rubbing so heavily upon the tool, that it often cuts into the tool causing a groove or depression.

16. The cutting edge below is engaged only in scraping and cutting off the small rough particles left upon the surface by the tearing action, thus giving a smoother finish. This edge almost always collects a small quantity of minute particles of metal which piles up on it and becomes almost welded to it.

17. The heat is naturally great. This heat is partially carried away by the tool itself (ample cross-section is therefore important) and by the *cooling lubricant* which must be directed (in large volume) directly at the point *upon the chip where it is being forced from the metal.*

18. Failure of the tool is caused by the excess heat which gradually accumulates—travels downwardly toward the cutting edge—and combined with the heat raised by the friction of this cutting edge on the metal, causes destruction of the cutting edge.

19. Naturally, the amount of heat generated depends upon the cutting speed, feed and depth of cut.

20. The cutting speed has more influence than the other two (2) factors. For a given quantity of metal to be removed, the heat factor increases much more rapidly when the cutting speed is increased and the depth of cut kept constant than if the cutting speed is kept constant and the depth of cut is increased.

21. This is due to the fact, first, that when the cutting speed is increased the friction of the chip is increased greatly and thus more heat is generated, and, second, when the depth of cut is increased, the additional friction and consequent heat from this increased size of chip upon the face of the tool does not increase in anywhere near the proportion as this increase in size of the chip. Also, this increased depth of cut brings more of the surface of the cutting edge of the tool into contact with the metal and thus more heat is conveyed away.

Cutting Cast Iron

22. In cutting or removing cast iron the speeds will be found lower than for steel. The metal possesses characteristics differing from those of steel. The chip does not form nor flow in the same manner. The metal crumbles away. Therefore, the work of removing the metal is largely done by the cutting edge as in this case there is little tearing away done in front of the tool. Therefore, the cutting edge fails quickly at high cutting speed. When there is a chip formed this strikes the tool very close to the cutting edge

and the heat generated by the friction travels quickly to this edge and thus causes its failure.

23. The same action follows when cutting steel at very low speed.

Quality of High Speed Tool Steel

24. The quality that makes high speed steel pre-eminent is not any exceptional quality of hardness. It is that inherent quality which enables it to *retain* its hardness even when heated to a high temperature In other words, the heat caused by the friction of the chip upon the tool does not have the same destructive effect as it does on a carbon tool steel. Therefore, a high speed steel tool will do a much greater amount of work than a carbon steel one.

25. Starting with carbon steel we next have the addition of tungsten (making mushet steel). (Molybdenum may be substituted though it is not so effective.) Then followed the addition of chromium and vanadium. Steels containing cobalt give good results on tests. Steelite has also shown excellent results for certain classes of work. Any of the reliable makes of tool steel will serve. Keep down to a minimum the number of different kinds.

Shape to Which Tool Should Be Forged

26. There are practically only four shapes to consider. First, the square section type used commonly in England and America. Second, the rectangular section type (width twice the height) used in America, in both of which the cutting edges are ground approximately level with the top of the tool. Third, the type proposed by F. W. Taylor in his "Art of Cutting Metals," wherein the nose and cutting edge are set well over to one side of the center line of the shank, and fourth, the method used in many American shops that are well managed, of forging the front of the tool above the level of the tool itself.

Shape Should Allow of as Many Regrindings as Possible

27. In considering the proper shape we must keep in mind that the re-drawing of a tool costs much more than the re-grinding and, therefore, a shape that can be re-ground only a few times before being re-dressed is expensive. The shapes should be such as to permit of as many regrindings before redressings as possible.

28. The Taylor method will allow of the greatest number of re-

grindings before redressing, but the shapes are difficult to attain and they require a very skillful smith.

The 4th Shape Best

29. In most shops the 4th shape where the front of the tool is slightly forged above the level of the tool body is the best for all practical purposes—it's the easiest to change to, and to maintain. Common sense teaches us that the fewer things we change in shop practice—or the smaller the change when changes have to come—the better.

30. The heat treatment of the tool steel by the smith for forging is important. The instructions of the makers of the steel should be secured and these adopted as your standard. They *must* not be deviated from. You must not allow your tool dresser to "use his judgment" or "be guided by his experience," for both judgment and experience may lead to a wrong practice that will result in serious deterioration of the tools.

Heat Treatment (Hardening) of Tools

31. I cannot emphasize too strongly two facts in connection with heat treatment. First, it is fundamentally important. If you do not get your tools properly hardened then the whole "scheme of things" falls down. Second, it is usually sadly neglected.

The Usual Method—with Bad Results

32. Usually the tool steel, after tests and careful selection, is handed over to the heat treater and he is turned loose on it. He is given full instructions on the proper method to treat the steel by the concerns who made it and who *ought* to know how it should be handled. But, nine times out of ten, the smith "uses his own judgment" or adopts a "secret method of his own," vainly imagining that he with his limited experience and with no knowledge of comparative tests, can do better than the maker.

33. The tools go to the shop foremen and they, having no standards to go by, accept them never realizing that they are not getting but a small percentage of their real efficiency. Such conditions must be overcome *at once.* You must adopt *standards* and *stick to them.*

Stick to Your Standards—First Step

34. Assuming that you have secured your steel you should con-

sult freely with the maker of it until you get a standard method of heat treatment that they approve of. The high-grade makers have every facility for making tests for you and assisting you to establish your standards and will always co-operate with you.

35. It is important that the head of your heat-treating department be in all these conferences and that he be allowed to ask all the questions he desires and acquaint himself with all conditions. Too often this matter is handled by a purchasing department that can know nothing about the question and too often all the heat treater gets is a set of instructions that he does not understand.

36. Be careful to get all the equipment needed for this work.

37. Excellent articles have appeared on the heat treatment of high-speed steel by F. W. Taylor in his book "Art of Cutting Metals," and also in proceedings of The Manchester Association of Engineers, by J. M. Gladhill, S. N. Brayshaw, C. P. Berg, W. Cutter. Mr. Taylor, with Mr. White, was the discoverer and inventor of the Taylor-White process of treating tool steel, and the developer of the modern tool steel with its tungsten, chromium, carbon, manganese, vanadium. Their composition and their treatment are described in his "Art of Cutting Metals," a book that every shop man should study.

Conclusion

38. Therefore: 1. Select a standard make of high-speed steel. 2. Get full instructions from the maker covering heat treatment. 3. Teach your men in the heat-treating department exactly how to treat this steel. 4. Teach them to abandon all of their own ideas and make them adhere to the determined upon standards.

GRINDING OF TOOLS

Cutting Edge—Lip and Clearance Angles—Side and Back Slope

Possible Standards

39. Experiments conducted by the thousands with scientific accuracy, practical production experience and a use of common sense has proven, beyond the peradventure of doubt, that there are on tools certain shapes of cutting edges, of lip and clearance angles, of side and back slope, that will give the best results.

Usual Practice

40. It is folly to leave the determination of these factors to the workmen or the foremen. Yet this is common practice. Often each workman is a "law unto himself" on this matter. It is often difficult to uproot this practice which has no basis in common sense. The men may wind out their stories about their experience in the shop, but as a matter of fact no workman, very few foremen and few superintendents ever had the opportunity to make any real tests upon which to base any accurate knowledge.

41. This grinding of tools by workers is very costly as the machine tools are shut down during this period, causing a tremendous waste.

Use of the Automatic Grinder

42. The grinding of proper and uniform angles on tools is a necessity. The promiscuous grinding of tools by the workmen will result in lack of uniformity and incorrect angles, which increases destruction of the tools, is very costly, and lowers the output. Therefore, it is necessary to use a first-class automatic tool grinder.

43. The automatic tool grinder will give you tools ground *correctly*—tools ground uniformly will provide an ample supply of tools ahead of the workmen, will save large sums that are lost through machine tools being shut down while workman is grinding his tools.

44. Many tools are ruined through overheating in grinding. Therefore, grind tools under a *heavy* flow of water.

The Standard Rules for Grinding Tools (for Roughing Cuts)

45. In this section we will consider:

(*A*) Shape of cutting edge;
(*B*) Lip and clearance angles;
(*C*) Side slope;
(*D*) Back slope.

Length of Time for Tool to Run Before Regrinding

46. On heavy jobs of removal of metal the best time to use as a standard for a tool to run on the average without it being necessary to regrind it is one hour and a half. All tables are built upon this.

Cutting Edge

47. It has been well established that the bigger the nose radius

the longer the tool will last. Our practical experience has proven this. The well-known English authority, F. Dempster Smith, states:

> "DURABILITY WITH NOSE RADIUS AND SECTION OF TOOL. In order to find how the durability was affected by a change in the nose radius of the tool, experiments were made on steel and cast iron with tools having a cutting angle of 75°; the depth of cut, traverse, cutting speed, etc., being kept constant.
>
> "Each set of tests was made in the ascending order of the nose radius; the tool, after failure, being simply re-ground to the larger radius. The tools in every case operated without a lubricant of any kind. The results of these trials show that the life of the tool becomes greater as the nose radius gets bigger, and generally conform to the expression
>
> $L =$ Constant $r^{3/2}$—Constant for steel.
>
> $L =$ Constant $r^{4/3}$—Constant for cast iron.
>
> "Where L is the life of the tool in minutes and r the radius of the tool nose in inches.
>
> "With the object of determining the separate effects, if any, of nose radius and cross-section a dozen tests were made with two tools 5/8 in. and 1 1/4 in. square, and with nose radii of 5/32 in. and 15/32 in., at a constant cutting speed and cut. Both tools were of the same quality, and were first tried with the larger radius, then with the smaller, and the results of repeated trials showed that in every case the lower durability accompanied the smaller nose radius, and further that the life of the tool was quite independent of its section.
>
> "Beyond an increased tendency to chatter, owing to the larger cutting edge engaged, there is no reason why the nose radius should not be as large as the width of the tool will allow.
>
> "Extended trials with many shapes of tools resulted in the adoption of the round nose, as used in the force trials, as the standard tool for roughing purposes, since it could be easily and economically forged, had a long life and freedom from chatter.
>
> "The round-nosed tool having a 5/8-in. nose radius, as referred to in the paper (and similar to that referred to in Fig. 31), is recommended for ordinary roughing purposes, since it has a comparatively long life, freedom from chatter, and can be easily and economically re-forged and re-ground."

THE CURVED CUTTING EDGE

48 F. W. Taylor states (in his "On the Art of Cutting Metals") that after considering the smallest possible liability to chatter, a true

finish, greater and more convenience to the operator and a cheaper tool dressing and grinding, he adopted as a standard, tools with curved cutting edges of a wide radius.

Straight Edge Causes Chatter

49. He establishes the same fact brought out by F. Dempster Smith and proved by experiments, that a straight edge tool, while very efficient from the standpoint of removal of metal, is much more liable to chatter and thus leave a bad finish. This liability of straight-edged tools to chatter was also proven by the elaborate experiments of Dr. Nicholson.

Curve Should Be as Large as Possible

50. It was this liability to chatter that led Taylor to recommend as his standards the tools with the curved cutting edge. This curve should be as large as possible, the limit being the point at which chattering is liable to occur.

Effect of Slow Speed

51. The liability of the tool to chatter diminishes as the cutting speed gets slower. Therefore, the tools for cutting hard steel and cast iron should run slower than for soft steel and should have a cutting edge with a large radius of curvature.

52. Taylor also brings out the interesting facts that cast iron is cut with less cutting pressure or resistance to the tool than is the case when removing soft steel, and that, therefore, in a given lathe, a greater depth of cut and coarser feed can be taken on cast iron than on soft steel, also that the coarser the feed the greater should be the radius of curvature of the nose of the tool to insure a smooth finish.

Shallow Cuts on Cast Iron

53. Comparatively shallow cuts on cast iron are the rule in many shops and in such cases broad feeds are necessary. Therefore, as Mr. Taylor brings out clearly, for such work the cutting edge may well approximate a straight line.

54. We must not overlook the point that after a tool has failed once it requires heat treatment to restore its lost vitality. How-

ever, after the first failure it retains the same average strength and vitality in case it is not so heat treated. We must, therefore, not expect the tool after the first failure to do the same amount of work as it accomplished the first cutting if it be not heat treated.

Conclusions

55. Wide shop practice shows that the best results can be obtained by adhering to the results secured by Nicholson, Taylor and Smith in regard to curved cutting edges of large radius. The shapes recommended by Taylor, in his "Art of Cutting Metals," can be safely adhered to for all around purposes.

Study Your Conditions

56. However, before adopting these shapes, a careful study should be made of the characteristics of the metal being worked upon and the effect of these characteristics upon the cutting edge when the lathe is run at the prescribed cutting speed, feed, depth of cut; the effort being to use as near an approximation to a straight cutting edge as is possible and at the same time avoid chatter.

Lip and Clearance Angles. Removal of Steel

57. As stated before, when cutting steel at high speed the metal is torn away by the tool in advance of the cutting edge. The cutting edge has practically no work to perform except to clean up the surface of the steel bar back of the shaving. The chip which is torn away from the bar strikes the tool at a point well above the actual cutting edge. The heat caused by this friction combined with the heat conveyed from the work itself causes the tool to fail (though much of this heat is carried away by the tool itself and also by the lubricant).

The Effect of Blunt vs. Acute Cutting Angles

58. It is thus clear that the blunter or more obtuse the cutting angle the greater the pressure and friction of the chip on the tool, hence the greater the heat. The more acute the cutting angle the less the pressure and consequent friction and hence, the less the heat.

59. For these reasons a tool operating on dead soft steel may have an acute angle as low as 60°, but this angle must become more obtuse (or blunter) as the metal is harder. Dr. Nicolson showed,

by his elaborate dynamometer experiments, that a minimum pressure on the tool results from the use of a tool with a cutting angle of 60° (clearance 6°, lip angle 54°). This, however, is too acute for general work as the life of such a tool is too short unless the steel is soft.

60. It is evident that a limit to the possible acuteness of this cutting angle will soon be reached for a tool with a cutting angle too acute will quickly crumble on its cutting edge.

The General Law of Determining Cutting Angles

61. From this we see that with any given metal to cut we should use that cutting angle which is as acute as possible and still will not crumble.

Proper Clearance and Lip Angles

62. There is a general uniformity amongst the men who have made the most exhaustive studies in regard to lip and clearance angles (Dr. Nicolson, F. W. Taylor, Dempster Smith and others). Their results are proven to be the best standards for every-day factory work.

Clearance Angles

63. There is a general agreement amongst the real workers in the factory field and those practical scientists who have done such excellent work that a clearance angle of 6° is the best. The clearance angle must not be so great as to result in weakening of the lip angle and causing crumbling of the cutting edge. Again, it must be great enough to avoid the danger of the work rubbing the tool for this addition will cause such an increase in heat caused by the friction as to quickly destroy the tool.

64. Examining tools ground by hand you will find much variation in this clearance angle—most of the cases will show an angle largely in excess of 6°, thus causing weakness of the tool, frequent failures, and losses due to too frequent regrinding and resetting of the tools. This loss of money due to frequent shutdowns and resetting of tools is astounding as this lost time always represents a large proportion of the total machine time. Again, when the tools are weakened by grinding too great a clearance angle thus reducing the lip angle, then the full allowable depth of cut cannot be taken.

Conclusion

65 Tools should be reground by an automatic grinder with a standard clearance angle of 6°.

CUTTING ANGLE—LIP ANGLE

Steel and Cast Iron—*F. Dempster Smith*

66. The English authority, F. Dempster Smith, sets down the proper cutting angle (i. e., cutting angle = lip angle plus clearance) as 65° to 70° on medium steel and 75° on cast iron—removal of metal and life of tool being considered. This means a lip angle of 59° to 64° and a clearance angle of 6° on medium steel and a lip angle of 69°, clearance angle of 6° on cast iron.

Steel and Cast Iron—*Dr. Nicolson*

67. Dr. Nicolson, in testing for the most efficient and most durable cutting angles in *cutting medium steel* found also that cutting angles of 65° to 70° or lip angle of 59° to 64° with clearance angle of 6° were the best.

68. Also, on cast-iron cutting angles ranging from 75° to 80° (depending upon quality of metal), giving lip angle of 69° to 74° with clearance angle of 6° were the best.

Soft Steel—*Mr. Taylor*

69. Mr. Taylor, in his "On the Art of Cutting Metals," shows that for cutting soft steel (softer than steels with carbon of 0.45%, 100,000 pounds tensile strength, 18% elongation) tools should have a cutting angle of 66° made up of clearance angle 6°, back slope 8°, side slope 22° or a lip angle of 61°.

70. On steels that are dead soft (carbon 0.10 to 0.15%) he considers that we may use a keener lip angle than 61°.

Steel and Cast Iron of Average Quality

71. For steel and cast iron of the average quality (carbon 0.45, tensile strength 100,000 pounds, elongation 18%) should have a cutting angle of 74°, clearance angle 6°, back slope 8°, side slope 14°, giving a lip angle of 68°.

This Angle Better Than Angle Generally Used

72. This angle is somewhat more acute than that used in many machine shops, the machinists in many cases insisting on a lip angle from 75° to 85°. Remember, that the more acute angle removes the metal with a lower resultant pressure on the tool. Mr. Taylor's tools with the more acute or keener lip angle are capable of standing heavier cuts than the blunter tools and, therefore, can remove more metal. Tests show, too, that a 68° angle working under such standard conditions is capable of doing the work without breaking down or crumbling.

Tire Steel

73. On work as hard or harder than tire steel Taylor recommends a cutting angle of 80°, clearance angle 6°, back slope 5°, side slope 9°, giving lip angle of 74°.

Chilled Iron

74. On chilled iron he recommends a lip angle of 86 to 90 degrees.

Cast Iron

75. Mr. Taylor brings out clearly the fact that for cutting cast iron a tool should have a blunter or more obtuse lip angle than for cutting soft steel. When he ran *on soft steel* with his tool ground to a lip angle of 68° he found it necessary to reduce his cutting speed from 150 feet down to 125 feet. When he ran his 68° lip angle tool at 150 feet the chip was badly distorted and stuck to the lip surface of the tool almost as if welded, thus causing a slowing down and stalling of the lathes, whereas, when he ran (on soft steel) with a tool lip angle of 61°, this action did not occur, and he could maintain the cutting speed of 150 feet.

76. For the softer grade of cast iron he recommends a lip angle of 68° (6° clearance angle, 8° back slope, 14° side slope) as compared with this one of 61° for soft steel, his test showing clearly that to get proper result on cast iron the lip angle must be blunter than is the case when removing soft steel. The reason for this is that in cutting cast iron the metal crumbles away before the advancing tool and often the work is done by the cutting edge itself. Therefore, if it be very acute it soon breaks down. Again, too, as

Taylor brings out, the chip in the case of cast iron strikes the lip surface of the tool much closer to the cutting edge than in the case of soft steel and, therefore, an acute lip angle tool will fail more quickly than a blunt one as there will not be sufficient cross section of the metal to carry away the heat properly. Therefore, on medium cast iron a lip angle of 68 degrees should be used.

Side and Back Slope

77. Practical experience and the experiments of Dr. Nicolson and F. W. Taylor show that a steep side slope is proper. Dr. Nicolson proves conclusively that a steep side slope diminishes the resistance to feeding. Mr. Taylor confirms this.

Advantage of Steep Side Slopes

78. The tool is therefore easiest to feed. The steep side slope forces the chip off sideways. The tool may be ground more times with steep side slopes than without it. The tool will not be deflected to one side.

Back Slope

79. As Mr. Taylor brings out, a certain amount of back slope is necessary to prevent the tool from being pushed away from the work, this action causing bad and irregular finish.

80. The final results of all these tests by these different experts are summarized in the following table.

TABLE OF COMPARISON

Type of Metal	Dr. Nicolson	Dempster Smith	F. W. Taylor	Clearance Angle	Back Slope	Side Slope	Lip Angle
	Cutting Angles						
Chilled Iron.......			92 to 96	6°			
Cast Iron.........	75	75	74	6°	8°	14°	68°
Hard Tire Steel...	80	80	80	6°	5°	9°	74°
Hard Steel........	80	80	74	6°	8°	14°	68°
Medium Steel...	65 to 70	65	67	6°	8°	22°	61°
Very Soft Steel...		61	below 67	6°			less than 61

81. The conclusions arrived at are proven to be right both through exhaustive careful tests and further by practical shop experience. Therefore, these angles may be adopted as standards without hesitation.

Lubrication

82. A $33^1/_3\%$ increase in output on parts made of soft steel, a 10% increase on those made of cast iron simply by doing away with the common method of weak and insufficient lubrication, substituting therefor a heavy flow of water, three (3) gallons per minute directed at the point where the chip is being forced from the forging, certainly makes "lubrication" loom up as a most important subject.

83. After giving a moment's thought to the action of the tool when removing metal—the tearing action as it proceeds, the heating of the tool through the absorption of heat from the hot metal itself and the heat caused by friction of the chips on the lip surface causing the gradual destruction of the cutting edge—it is easily seen that one of the important points is to carry away that heat before it can affect the cutting edge.

Water in Large Volume

84. Of course, the simplest and best way is to pour a *heavy* stream of water directly on the point where the chip is being removed from the body, this water to be thoroughly impregnated to the point of saturation with soda to prevent rusting.

85. Now when we say a heavy stream of water we mean 2½ to 3 gallons per minute and not a stream such as we often see, so small that necessarily it does no appreciable good. The workmen will always object to this heavy stream because considerable splashing will result unless special arrangements to prevent this are provided. Watch and see that these men direct the stream of water *at the point* where the metal is being removed because otherwise they will direct it at the forging just above the chip and thus reduce the splashing, the life of the tool and the speed of removal of metal at the same time.

Great Gains Possible

86. These great gains in output so greatly outweigh any other consideration that the plan cannot be argued against. Taylor and other experimenters found the following interesting results: (1) A gain of 40% in output in working steel can be reached where a large volume of water (3 gallons per minute) is turned directly on a tool 2 inches by 2½ inches (a smaller volume when the tool is smaller), at the point where the metal is being removed as compared

with the results when running dry or under inefficient conditions of lubrication.

87. (2) Notwithstanding the old shop theory that water cannot be used when cutting cast iron, still Taylor showed that a gain of 10% in output can be secured by directing the heavy stream of water at the point where the metal is being removed.

88. This method of getting a large gain in production is so effective that it should be one of the first problems to be grappled with. It is a simple proposition to install the necessary piping and arrangements for protecting the workmen against undue splashing. Simply arrange to turn three gallons of water per minute on the work and your output can be made to literally jump.

Conclusions

89. In planning for increasing production, the first thing to do is to fit up your lathes so that a heavy supply of soda water (3 gallons per minute for a tool 2 in. by 2½ in. and less as the tool may be smaller) will be directed at the spot where the metal is being removed.

Tables of Cutting Speeds—Feeds—Depth of Cut for Roughing Cuts of Standard High Speed Tools on Soft, Medium and Hard Steel—and on Soft, Medium and Hard Cast Iron.

90. Some years ago the writer made elaborate tests covering this important subject and established tables of standard cutting speeds, feeds and depth of cuts on different metals for lathes, planers, shapers, milling machines, boring mills, drill presses.

91. The data secured revealed an amazing situation in a large shop that was seemingly operating efficiently; it showed that the outputs when the machine tools were operating was far below what they should have been—and a little study of what the output *should* have been if the machine tools had run up to full time—and a comparison with *actual* results showed clearly another tremendous loss due to machines operating only a portion of their full time, due to delays in the flow of materials, machines down dead while workmen ground their own tools and merrily chatted with other waiting workmen about the last baseball game, insufficient supply of tools, needed fixtures laid up in the tool room for repairs.

After We Started to Use These Tables We Soon Got Results

92. On the planer job we more than doubled the output. The

time of one important job was cut down from 19 hours to 5½ hours, another from 10 hours to 3 hours. In a short time 13 planers were producing a much larger output than 19 did formerly. In the machine room the output was tripled. Twenty-two men produced more than 63 formerly. I have had a number of cases where the production of machine rooms was more than doubled. In heavy operations the output per machine tool was almost tripled.

93. And so it has gone for years in every shop taken hold of in a practical manner. Every investigation has uncovered new inefficiencies and new opportunities for improvement.

94. After a lengthy practical experience and careful investigation of the excellent work of Dr. Nicolson, Professor William Ripper, F. W. Taylor as well as the work done under my supervision, I find that, all in all, the most accurate, comprehensive, reliable tables are those given by F. W. Taylor in his book "On the Art of Cutting Metals."

95. Mr. Taylor's methods of investigation were exceedingly thorough—every element of the problems being studied—and the results given are after 30 years of effort and over 30,000 experiments, he using testing apparatus and facilities that cannot be available to the usual investigator or shop superintendent. Therefore, taken as a whole, Mr. Taylor's work on this matter must be accepted by any man who reads carefully his book as authoritative.

96. I present on pages 196 to 206 these tables of Mr. Taylor's (by permission), and recommend them as showing fairly and conservatively the result that any first-class machine shop ought to get on roughing cuts on soft, medium and hard steel and cast iron, provided it has standardized its tools, heat treatment, shapes and lubrication.

Using These Tables

97. It is not always as simple a matter as might appear to get your organization to fall in line with you in the introduction of improvements. Do not forget that it is simply human nature for any man to oppose the introduction of any new methods that will prove that he had previously operated his department inefficiently.

The Opposition Is Human Nature

98. If you, Mr. President or General Manager, wish to understand the feelings of the shop foremen and superintendent over

such matters just picture your own mental attitude toward a man that your board of directors had set at the job of finding out *your* inefficiencies and improving *your* work—at the same time exposing all *your* faults and failures.

Tact or Diplomacy

99. For the successful and quick introduction of such big improvements that will inevitably lead to big increases in production, *Tact* and *Diplomacy,* spelled with capital letters *must* be used.

100. It's quite true that when I found that my planer job—my machine room—were operating at less than half efficiency when I needed the work out of them so badly, I felt like "firing" the whole bunch of foremen and using a club to emphasize my displeasure. But that method would have aroused fear and opposition among the rest and I would have been no better off, for the new men would not have known any more than the old.

101. I give now the exact plan always pursued. I am confident that, if it is followed out thoroughly, success will come. Results will not be secured by rushing wildly at this work and trying to force it through. It must be gone at step by step, each one being a sound one.

The Man to Do the Testing

102. The first step is a vital one. Much of the success of these methods will depend upon it. It involves the SELECTION OF THE MAN to head this job, to carry out all the experiments, who will be responsible (even though aided by the committee) for the successful carrying out of each and every step.

These will include:

(*a*) The selection of the steel;
(*b*) The determination of the proper method of forging shapes;
(*c*) Determining standard method of hardening;
(*d*) Determining standard shapes and angles to which tools must be ground;
(*e*) Method of grinding;
(*f*) Method of lubrication;
(*g*) Method of handling work so that all the factors will be so performed as to reduce *the time spent on handling work to the lowest possible point;*

(*h*) Determining the best cutting speeds, feeds and depth of cuts for the different metals and the different parts so that the *removal of metal shall be done in the shortest possible time.*

The Necessity for a High-Grade Man

103. When consideration is given to the importance of this work it is readily seen why I press so strongly on the necessity of securing a high-grade man to head this work and why I insist that he should be aided by a committee of the best brains in the organization.

The Usual Error

104. I have often found that a manufacturer when considering starting the work of this character, thinks that it involves simply the testing out of a few jobs on a machine tool—the noting of the data of the test—and the use of it in the shop, this plan resulting in the neglect of the other fundamentally important factors. This job is *far* more than this.

The Chief Fault with Most Attempts

105. My reason for putting one man in charge of this entire work (under the direction of the factory manager or superintendent) is that in this way *all* of these details will be attended to. So often is the work undertaken in a way that will lead to incomplete results or failures.

The chief faults with most attempts to solve this problem of establishing "Standard Hourly Outputs" is that only one or two of the important elements are attacked and others are neglected which neglect only brings about failure of the whole attempt. For example: The first attempt is usually made to reduce the time required for machining of the part; no attempt being made to first standardize the steel used, shapes to adopt, method of hardening.

The second mistake is to carefully select for the test some tool that is first class in every respect, that will give good results, but that is *not* representative of the whole lot of tools in the tool supply. The tests are made upon some particular part. Excellent results are gotten—everyone becomes much interested and elated over these results that are going to "revolutionize production." Then a few

months afterwards you find the whole thing dead—the shop running as formerly.

What is the trouble? Usually the whole matter is not followed up properly. It's a big job in itself for a good man, and unless it is followed up everlastingly, it will surely "die the death." Again, too, the foremen, in trying out the results of these tests, find that the small tools he gets from stores will not stand up under the strain; they being improperly hardened and ground, and, after a number of attempts to get better results, give up the struggle.

Select Your Best Man

106. It is therefore *imperative* that you select for this work one of your best men, preferably an assistant foreman. This man must *always be made a foreman* if he is not already one. His skill and knowledge as a mechanic must be unquestioned. Above all, he must be a man with a well-developed "production sense." That is, one who is keen on the question of devising ways and means to crowd production out of a job. This is more important than at first appears for many a high-grade mechanic has acquired at his toolmaking trade such a leisurely slow manner of doing work that it is difficult and often impossible for him to develop into a "big producer."

The Inexperienced Man Will Not Do

107. A moment's thought will show why inexperienced mechanics or office men can never do this work—and then, too, the shop men *know* that they can't and have a good healthy contempt for any figures they send out, and pay little attention to them when they get them. There are a dozen other reasons why such methods will not work, but these two—the inexperienced office men *can't* do it; the shop men *know* they can't—are so decisive that we can forget the rest.

108. I know that I am at variance with some production engineers on this point; but, a hard practical experience in shop work has taught me that this job of determining the proper standards of cutting speeds, feeds and depth of cuts and hence, standard hourly production, is a regular "he man's job" requiring skill—knowledge of the art and practice of mechanics—and a reputation amongst the shop men of knowing your business and so stifling any disputes over "it cannot be done." Best of all, my method

will bring *quick* results. You do not have to wait half a life-time trying to break in inexperienced men on this job that an experienced man will handle properly and efficiently almost immediately.

The Committee

109. This work is so important that I have found it always advantageous to have him work (under the general superintendent) with a committee composed of superintendent of production, superintendent of assembly, superintendent of inspection, chief engineer, head of cost department—this committee to be advisory in character only, even though the attitude of some of the committee may, at first, be hostile. It will be found that as he develops the different advantageous points, their interest will grow and as the plans prove to be practical and valuable, they will always grow enthusiastic. It is often wise to call in the foreman of the job being tried out. He thus has no "comeback" later. Thus, you then soon get their co-operation which is of great help—and also their suggestions are always of much value. Thus you do away with the shop opposition for, by the time the data on standard hourly outputs is ready for the shop your main production men have not only learned their worth and value but have had a share in establishing them.

Reports

110. As this "expert on standards" progresses he must make daily written reports of his experiments—his successes and failures. Not a point can be overlooked. The accumulation of such data is valuable.

How to Make Speed

111. With the information now at hand there should not be much time consumed in determining character of steel to use, determining methods of hardening, determining best cutting angles, best methods of lubrication. The data herein submitted, gathered from every authoritative source, cover these points and it will be found simple for the "expert on standards" to establish from these, standards that will fit the conditions of the shop.

The Standards to Be Settled

112. (*a*) The standard of tool steel to be used;
(*b*) The standard shape tools should be forged;

(*c*) The standard unvarying methods of hardening;
(*d*) The standard method of grinding;
(*e*) The standards of cutting edges and cutting angles;
(*f*) The standards of lubrication;
(*g*) The standards of cutting speeds, feeds and depth of cuts;
(*h*) The standards of hourly output.

The Place to Do the Testing

113. Again, I emphasize the fact that the testing in the shop during working hours must be avoided. The very *worst* place to do this testing is in the shop during working hours. The instant the workingmen see a skilled foreman testing out outputs just that moment does trouble begin to foment. *They* know better than anyone else that such tests will show that outputs can easily be increased greatly. They feel, whether correctly or not, that this will surely mean a cut in the rate of pay—a big increase in the rate of production—their working harder with no more pay. In view of their past experiences they see no other outcome. They commence to form the lines ready for combat, whether the factory be union or open shop. The workingman, union or non-union, hates the very name and idea of "time-study." He associates with it the idea of the hated "pacemakers"—the placing of so high a standard of production that only the most skilled can reach the mark by strenuous effort—that the average worker cannot reach, that the old worker will fall far below. Therefore, use a separate room as far removed from the factory as possible—put in this room temporarily for the period of the tests, such lathes, milling machines, etc., as you may require. Then the tests can be carried out easily and correctly. No word of this procedure should be allowed to get to the shop.

Nature of the Tests

114. Again, I caution against methods of testing that will lead to standards placed so high as to fatigue the worker unduly or make it possible for only the very speedy worker to earn good wages. This will only justify the workers' hatred of the pacemaker and will lead to trouble.

115. THE STANDARDS OF OUTPUT MUST BE SUCH AS THE AVERAGE WORKER CAN REACH WITHOUT UNNECESSARY FATIGUE AND EXHAUSTION. COUPLED WITH THIS MUST GO A SYSTEM OF WAGE THAT

WILL REWARD THE WORKER GENEROUSLY WHEN HE REACHES SUCH OUTPUT. YOU MAY FEEL SURE THAT SUCH OUTPUT WILL BE SO FAR ABOVE YOUR PRESENT AVERAGE PRODUCTION AS TO RIGHTLY REPAY THE EFFORT AND MAKE ECONOMICAL THE INCREASES IN PAY.

116. Classify all the jobs in the shop under (*a*) metals; (*b*) the type and size of machine tool upon which the work is to be done; that is, all work done on a 10-in. lathe put in one group; on 14-in. lathe in another; on No. 2 mills in another. Then out of each group select a number (say 10) of jobs that may be considered representative of each group.

117. FIRST STEP. Then list up the biggest and most important jobs in the shop for first attention.

118. SECOND STEP. Study carefully the metals that are to be handled and ascertain if and how they differ from the metals dealt with in these tables.

119. THIRD STEP. Have an examination made of all castings, forgings, bar stock to ascertain if reductions in size can be economically made in order to reduce the amount of metal to be removed. Surprising savings can often be made by doing this.

120. FOURTH STEP. Make a careful selection of the high-grade tool steel to be used. Get a high-grade, well-tried-out standard article. Keep in mind always the desirability of ***keeping down to a minimum*** the number of different kinds of steel and also the different sizes.

121. FIFTH STEP. Determine the shapes to which the tools should be forged by giving due consideration to the character of the metal to be machined and work to be performed. The various shapes, English and American, should be gone into and the proper ones adopted as standards. Consider the skill required and cost of tool dressing as compared with cost of regrinding before tools must be redressed.

122. SIXTH STEP. After consultation with the maker of the high-speed steel and a careful study of articles by F. W. Taylor, Gledhill, Brayshaw, Berg, Carter and others, a *standard* method of hardening must be determined upon.

123. After the standards are fixed then call your *entire* heat treating department together and explain it, giving each of them FULL WRITTEN INSTRUCTIONS. Then have them heat treat and harden sample tools in this standard manner in the presence of your special investigator and the superintendent.

124. Give every new employee of this department the same written instructions and make him demonstrate.

Put up on the walls of this department the same written instructions as permanent EXHIBITS.

Take *nothing for granted* and leave no chance for deviation from standards.

125. SEVENTH STEP. Have the special investigator with the superintendent determine upon the proper standards for shape of cutting edges and lip and clearance angles and side and back slope. Consider carefully the metal to be worked upon and use the data given herein for all grades of steel and cast iron as your guide.

126. EIGHTH STEP. Determine the minimum number of tools needed *to keep the workmen continuously busy*, figuring regrinding every 90 minutes and considering time required for grinding. Figure generously and then get the proper number of automatic tool grinders to do the work. Train your men handling these machines, showing them how you want this work done.

127. NINTH STEP. Study your problem of lubrication (in fact, the term cooling is better), keeping in mind that soda water in a heavy stream must be directed at the point where the metal is being removed. The water will splash, the workmen will object, yet the gain in output is so great that no objections have any weight. Provide means to reduce the chance of the splashing water getting on the workmen. The necessary water connections should always be of ample size and strong.

128. TENTH STEP. The next step, and an important one, is the "DETERMINATION OF THE SHORTEST POSSIBLE TIME REQUIRED FOR THE HANDLING AND THE SET UP FOR ANY JOB AND THE STANDARDS OF TIME THEREFROM."

THE TEST FOR "HANDLING AND SET UP" TIME

129. "Handling and set up time" determinations are such important items on many machine tools that they deserve special attention. The general principles given below are comprehensive enough to fit any case.

THE FIRST PRINCIPLE IS TO TAKE ANY JOB AND DIVIDE IT INTO ITS ELEMENTS. THE OBJECT IS TO TIME OUT THESE ELEMENTS ONE BY ONE AND SO REACH STANDARDS FOR EACH AND THEN DETERMINE TOTAL TIMES IN ORDER TO GET STANDARD OF HOURLY OUTPUT FOR THE JOB AS A WHOLE.

THE DIVISION OF THE TOTAL TIME REQUIRED FOR A PIECE OF WORK

130. The total time required for the completion of a job is divided into handling time, set up time, removal of metal time.

All of these can be readily divided into certain general elements of classification which must be considered carefully. These are:

131. FIRST. All needed cutting tools already ground; all clamps, stops, setting up tools of all kinds, jigs and fixtures; all gages, blueprints, instruction cards, are to be on hand in workman's cabinet.

132. SECOND. The part or parts to be worked on are to be at the proper place on the floor or on the table near the tool.

133. THIRD. The machine tool must be made ready for the new work.

134. FOURTH. If the work and the machine tool are ready and the work must be handled by a crane then this element is the hoisting and placing the work on the machine bed.

If the work is comparatively light then the elements is the lifting of the part to the machine and chucking it or otherwise placing it in its jig or fixture.

134*a*. FIFTH. This element covers the truing up, leveling and squaring up of the work.

135. SIXTH. Is the clamping on work and adjusting stops.

136. SEVENTH. Next comes the adjusting of the tools so as to take the standard cut and the adjustment of the machine for the standard cutting speed and rate of feed. This will include any gaging or calipering of work.

137. EIGHTH. This element is the important one of removal of metal. With cutting tools standardized throughout and using the tables provided, this now becomes a simple matter. This also includes the gaging or measuring up of work to see that it is within the allowable tolerances.

138. NINTH. This element is the loosening and removal of clamps and stops or the opening up of jig or fixture.

139. TENTH. The removal of the part from the machine tool to its proper place on the floor or in the box.

140. ELEVENTH. Removal of used tools from machine and placing these with all clamps, stops, fixtures and blueprints in the cabinet to be placed back into cabinet.

141. Take as a concrete example, a job on a planer. Assume that piece is in standard place on floor and that tools are in tool cabinet. These elements are as follows:

(*a*) Preparation of planer for the work—gathering from the cabinet the necessary clamps, stops, tools and blueprints.
(*b*) Hoisting work by crane to planer bed.
(*c*) Leveling up work on planer bed.
(*d*) Adjusting and tightening up clamps and stops.
(*e*) Adjusting heads—placing tools therein.
(*f*) Adjusting tools to give proper depth of cuts.
(*g*) Adjusting planer speeds to standard.
(*h*) Removal of metal and gaging.
(*i*) Stoppage of planer to replace dulled tools.
(*j*) Loosening and removing clamps and stops.
(*k*) Removal of work from bed.
(*l*) Removal of used tools from machine and placing them —clamps, stops, blueprints—in the cabinet. The used tools to be placed in a "used tool" compartment so that they can be easily secured for regrinding.

142. After a job has been analyzed into its elements then come first the study of each element so as to work out improvements; second, the timing out of each element by careful stop-watch tests.

It is always surprising to see how the careful study of *each* of the elements of "handling and set up time," one by one, will lead to great improvements. You can see clearly what elements are taking the longest times and then can almost always devise ways and means for quickening the time of these elements. It is far better to study each of these elements separately than to try to study the job as a whole.

I Do Not Divide My Elements as Finely as Others

143. A production man who has followed recent practice and writings of efficiency engineers and compares their minute separation of handling and set up jobs with mine, will at once note that I do not provide for the same degree of small subdivisions of elements as do they. They time out the tightening of a bolt, the picking up of a tool, the walking from one side of the machine tool to the other in hundredths of a second. No doubt they secure excellent and accurate results thereby. For myself, however, I use this minute subdivision of elements only on the jobs where the handling time is the big factor, such as quick machining jobs, bench work, and especially assembling.

144. I have found in actual factory practice that in timing out

DETERMINATION OF STANDARD HOURLY OUTPUT

DATE ....

PART .... OPERATION .... WEIGHT ....
SIZE-TYPE MACHINE TOOL .... CUTTING TOOLS ....
ROUGHING OR FINISHING CUT .... FIXTURES OR JIGS ....
NO. PARTS USED ON TEST NO 1 .... TEST NO. 2 .... TEST NO. 3 ....
BLUE PRINT NO. ....

TIME REQUIRED TO=	TEST NO. 1		TEST NO. 2		TEST NO. 3		STANDARD	
	TIME	NOTES	TIME	NOTES	TIME	NOTES	TIMES	
(1) *PREPARE MACHINE TOOL*								
(2) *PLACE WORK ON MACHINE*								
(3) *TRUE & LEVEL UP WORK*								
(4) *CLAMP WORK-ADJUST STOPS*								
(5) *ADJUST CUTTING TOOL*								
(a) *Cutting Speed* .... (b) *Feed* .... (c) *Depth of Cut*								
(6) *REMOVE METAL*								
(7) *LOOSEN & REMOVE CLAMPS*								
(8) *REMOVE WORK*								
(9) *REMOVE TOOLS, GAGES, ETC.*								

STANDARD TOTAL TIME ....
STANDARD HOURLY OUTPUT ....
SIGNATURES .... SUPERINTENDENT
PRESENT AT TEST .... FOREMAN
.... FACTORY SYSTEM

Use Back of This for Special Notes.

NOTES ON 1	*Use This Side for Special Notes upon the 9 Elements.*
NOTES ON 2	
NOTES ON 3	
NOTES ON 4	
NOTES ON 7	
NOTES ON 8	
NOTES ON 9	

FIGURE 20.—Observation Form for the Determination of Standard Hourly Output, Refer to Paragraph 146

of my elements, which include relatively many movements, I always have reached a total time that is practically equal to that secured by a much greater analysis and, most important of all, I have saved

a great deal of time in my try-outs and tests. This is practically true in the case of those jobs where the time for "removal of metal" is relatively much larger than the "handling and set up time."

Determining Quickly This Time on New Jobs

145. After your "expert on standards" has been getting the time on these elements for a period, he will find it easily possible to set accurately the "handling and set-up time" on entirely new jobs without tests for the elements on the new job will be similar to other elements on different jobs already timed out.

Forms

146. A factory man is prone to put his test data down on scratch pads or yellow slips of paper, get a final result, then lose or destroy the original record containing the history of the case so that no one can tell how the results have been reached. This is very mischievous and MUST NOT BE PERMITTED. On the other hand, I have usually found amongst the fledgelings a strong tendency to load up on printed forms only to find out that these forms are no good because they either forget some important column, or the form did not fit in with shop conditions. I am, therefore, partial to typewritten cards as forms to start with until final conditions are arrived at. But form you MUST use. Refer to arrangement of Figure 20.

Simplify Your Forms

147. It is always an advantage to have the whole story on one sheet. This one carries all essential and desirable information. Never try to have a form cover "all creation." The new hand puts on it everything—and no one uses it. An old hand keeps it as simple as possible.

The Tables of Cutting Speeds, Feeds and Depth of Cuts

148. We now come to the important tables of cutting speeds, feeds and depth of cuts for soft, medium hard and hard steel and soft, medium hard and hard cast iron. These invaluable data represent tens of thousands of experiments and many years of work on the part of F. W. Taylor. They first appeared in his book "On the Art of Cutting Metals," which should be in the library of every shop superintendent. They are more complete than tables compiled by myself or any other, and I am reproducing them by permission.

PRACTICAL TABLE OF CUTTING SPEEDS—STEEL

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard steel, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard 1¼-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft steel	Medium steel	Hard steel
3/32	1/64	518	259	118
	1/32	366	183	83.2
	1/16	257	129	58.4
	3/32	209	105	47.5
1/8	1/64	450	225	102
	1/32	317	158	72.0
	1/16	223	112	50.7
	3/32	182	90.8	41.4
	1/8	157	78.5	35.7
3/16	1/64	370	185	84.1
	1/32	260	130	59.1
	1/16	183	91.7	41.6
	3/32	149	74.6	33.8
	1/8	129	64.5	29.3
	3/16	105	52.6	23.8
1/4	1/64	322	161	73.2
	1/32	227	113	51.6
	1/16	159	79.7	36.1
	3/32	130	65.0	29.5
	1/8	112	56.1	25.5
	3/16	91.4	45.7	20.8
3/8	1/64	264	132	60
	1/32	186	93.1	42.3
	1/16	131	65.5	29.8
	3/32	107	53.4	24.1
	1/8	92.2	46.1	20.8
1/2	1/64	230	115	52.3
	1/32	162	80.9	36.8
	1/16	114	56.9	25.9
	3/32	92.6	46.3	21.0

PRACTICAL TABLE OF CUTTING SPEEDS—STEEL

ROUGHING CUTS

Corresponding to different depths of cut and thickness of feed on soft, medium and hard steel, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

STANDARD 1-IN. TOOL

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding		
		Soft steel	Medium steel	Hard steel
	1/64	490	245	111
3/32	1/32	339	169	77.0
	1/16	235	117	53.4
	3/32	189	94.5	43.0
	1/64	427	214	97.0
	1/32	296	148	67.2
1/8	1/16	205	102	46.6
	3/32	165	83.0	37.5
	1/8	142	71.0	32.3
	1/64	358	179	81.3
	1/32	247	124	56.1
3/16	1/16	171	85.5	38.8
	3/32	138	69.0	31.3
	1/8	118	59.0	26.8
	3/16	95.0	47.5	21.6
	1/64	315	157	71.6
	1/32	218	109	49.5
1/4	1/16	150	75.0	34.1
	3/32	121	60.5	27.5
	1/8	104	52.0	23.6
	1/64	263	132	59.8
3/8	1/32	182	91.0	41.4
	1/16	126	62.8	28.5
	3/32	101	50.6	23.0
	1/64	232	116	52.7
1/2	1/32	161	80.5	36.6
	1/16	111	55.7	25.3

PRACTICAL TABLE OF CUTTING SPEEDS—STEEL

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard steel, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard 7/8-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding		
		Soft steel	Medium steel	Hard steel
	1/64	476	238	108
3/32	1/32	325	162	73.8
	1/16	222	111	50.4
	3/32	177	88.4	40.2
	1/64	420	210	95.5
	1/32	286	143	65.0
1/8	1/16	195	97.6	44.4
	3/32	156	77.9	35.4
	1/8	133	66.4	30.2
	1/64	352	176	80.0
	1/32	240	120	54.5
3/16	1/16	164	82	37.3
	3/32	131	65.5	29.8
	1/8	112	56.0	25.5
	1/64	312	156	70.9
1/4	1/32	213	107	48.4
	1/16	145	72.6	33.0
	3/32	116	58.1	26.4
	1/64	264	132	60
3/8	1/32	180	90.2	41
	1/16	122	61.1	27.8
1/2	1/64	237	118	53.8
	1/32	162	80.8	36.7

PRACTICAL TABLE OF CUTTING SPEEDS—STEEL

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard steel, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard ¾-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft steel	Medium steel	Hard steel
	1/64	482	241	110
3/32	1/32	323	161	73.4
	1/16	217	108	49.3
	3/32	172	85.8	39.0
	1/64	423	212	96.1
	1/32	284	142	64.5
1/8	1/16	190	95.2	43.2
	3/32	151	75.3	34.2
	1/8	128	63.8	29.0
	1/64	358	179	81.4
3/16	1/32	240	120	54.5
	1/16	161	80.5	36.6
	3/32	127	63.7	28.7
	1/64	320	160	72.7
1/4	1/32	215	107	48.8
	1/16	144	72	32.7
3/8	1/64	276	138	62.7
	1/32	185	92.4	42.0

PRACTICAL TABLE OF CUTTING SPEEDS—STEEL

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard steel, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard ⅝-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft steel	Medium steel	Hard steel
	1/64	548	274	125
1/16	1/32	358	179	81.6
	1/16	235	117	53.3
	1/64	467	234	106
3/32	1/32	306	153	69.5
	1/16	200	100	45.5
	3/32	156	78.0	35.5
	1/64	417	209	94.8
1/8	1/32	273	136	62.0
	1/16	179	89.3	40.6
	3/32	140	69.8	31.7
	1/64	362	181	82.2
3/16	1/32	236	118	53.8
	1/16	155	77.4	35.2
1/4	1/64	328	164	74.5
	1/32	215	107	48.8
3/8	1/64	286	143	65

PRACTICAL TABLE OF CUTTING SPEEDS—STEEL

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard steel, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard ½-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding		
		Soft steel	Medium steel	Hard steel
	1/64	510	255	116
1/16	1/32	322	161	73.2
	1/16	203	102	46.2
	1/64	445	223	101
3/32	1/32	281	141	63.9
	1/16	177	88.7	40.2
	3/32	135	67.4	30.7
	1/64	404	202	91.8
1/8	1/32	255	128	57.9
	1/16	161	81	36.6
3/16	1/64	359	179	81.6
	1/32	226	113	51.4
1/4	1/64	330	165	25.0

PRACTICAL TABLE OF CUTTING SPEEDS—CAST IRON

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard cast iron, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard 1¼-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft cast iron	Medium cast iron	Hard cast iron
	1/64	239	119.6	69.8
	1/32	191	95.3	55.6
3/32	1/16	142	70.8	41.3
	3/32	118	59.1	34.4
	1/8	103	51.7	30.2
	3/16	85.0	42.5	24.8
	1/64	216	108	63.1
	1/32	172	86.2	50.3
1/8	1/16	128	64.0	37.3
	3/32	107	53.4	31.2
	1/8	93.4	46.7	27.3
	3/16	76.8	38.4	22.4
	1/64	187	93.5	54.6
	1/32	149	74.6	43.6
3/16	1/16	111	55.5	32.7
	3/32	92.5	46.3	27.0
	1/8	73.1	36.5	21.3
	3/16	66.4	33.2	19.4
	1/64	168	84.1	49.1
	1/32	134	67.2	39.2
1/4	1/16	99.8	49.9	29.1
	3/32	83.2	41.6	24.3
	1/8	72.6	36.3	21.2
	3/16	59.7	29.8	17.4
	1/64	144	71.8	41.9
	1/32	115	57.3	33.4
3/8	1/16	85.1	42.6	24.8
	3/32	70.9	35.5	20.7
	1/8	62	31	18.1
	3/16	51	25.5	14.9

Practical Table of Cutting Speeds—Cast Iron—*Continued*

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft cast iron	Medium cast iron	Hard cast iron
	1/64	131	55.6	38.3
	1/32	105	52.3	30.5
1/2	1/16	77.6	38.8	22.7
	3/32	64.7	32.4	18.9
	1/8	56.6	28.3	16.5
	3/16	46.5	23.3	13.6
	1/64	112	56	32.7
	1/32	89.2	44.6	26
3/4	1/16	66.2	33.1	19.3
	3/32	55.2	27.6	16.1
	1/8	48.3	24.2	14.1
	3/16	39.7	19.8	11.6

PRACTICAL TABLE OF CUTTING SPEEDS—CAST IRON

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard cast iron, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard 1-In. Tool

Depth of cut in inches	Feed in in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft cast iron	Medium cast iron	Hard cast iron
	1/64	226	113	66
	1/32	177	88.4	51.6
3/32	1/16	130	64.8	37.8
	3/32	107	53.5	31.2
	1/8	92.8	46.4	27.1
	3/16	75.7	37.8	22.1
	1/64	205	102	59.8
	1/32	160	85.1	46.8
1/8	1/16	118	58.8	34.3
	3/32	97.0	48.5	23.3
	1/8	84.2	42.1	24.6
	3/16	68.6	34.3	20
	1/64	181	90.6	52.9
	1/32	142	70.8	41.3
3/16	1/16	104	51.9	30.3
	3/32	85.8	42.9	25
	1/8	74.3	37.2	21.7
	3/16	60.6	30.3	17.7
	1/64	165	82.3	48.1
	1/32	129	64.4	37.5
1/4	1/16	94.3	47.1	27.5
	3/32	77.8	38.9	22.7
	1/8	67.5	33.7	19.7
	3/16	55	27.5	16.1
	1/64	143	71.5	41.8
	1/32	112	56	32.6
3/8	1/16	81.9	41	23.9
	3/32	67.6	33.8	19.7
	1/8	58.6	29.3	17.1
	3/16	57.5	28.7	16.8
	1/64	132	66.2	38.6
	1/32	104	51.6	30.2
1/2	1/16	75.8	37.9	22.1
	3/32	62.6	31.3	18.3
	1/8	54.2	27.1	15.8
	3/16	44.2	22.1	12.9

PRACTICAL TABLE OF CUTTING SPEEDS—CAST IRON

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard cast iron, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard ⅞-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft cast iron	Medium cast iron	Hard cast iron
	1/64	220	110	64.2
	1/32	169	84.6	49.4
3/32	1/16	122	61.2	35.7
	3/32	99.8	49.9	29.1
	1/8	86.4	43.2	25.2
	3/16	70.1	35.1	20.5
	1/64	202	101	58.9
	1/32	156	77.8	45.4
1/8	1/16	112	56.2	32.8
	3/32	97.8	45.9	26.8
	1/8	79.3	39.7	23.2
	3/16	64.3	32.2	18.8
	1/64	178	89.0	52
	1/32	137	68.6	40.1
3/16	1/16	99.4	49.7	29
	3/32	81	40.5	23.7
	1/8	70.1	35	20.5
	3/16	56.8	28.4	16.6
	1/64	163	81.5	47.7
	1/32	126	62.9	36.7
1/4	1/16	90.8	45.4	26.5
	3/32	74.1	37	21.6
	1/8	64.1	32	18.7
	3/16	52	26	15.2
	1/64	144	71.8	41.9
	1/32	111	55.4	32.3
3/8	1/16	80	40	23.4
	3/32	65.3	32.6	19.1
	1/8	56.4	28.2	16.5
	3/16	45.8	22.9	13.4
	1/64	135	67.5	39.4
	1/32	104	52.1	30.4
1/2	1/16	75.2	37.6	22
	3/32	61.4	30.7	17.9
	1/8	43.1	21.6	12.6

PRACTICAL TABLE OF CUTTING SPEEDS—CAST IRON

ROUGHING CUTS

Corresponding to different depths of cut and thickness of feed on soft, medium and hard cast iron, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

STANDARD ¾-IN. TOOL

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding		
		Soft cast iron	Medium cast iron	Hard cast iron
	1/64	222	111	65
	1/32	169	84.3	49.2
3/32	1/16	120	59.8	34.9
	3/32	97	48.5	28.3
	1/8	83.4	41.7	24.4
	3/16	66.4	33.2	19.4
	1/64	203	102	59.3
	1/32	156	78.2	45.6
1/8	1/16	110	55	32
	3/32	88.8	44.4	25.9
	1/8	76.2	38.1	22.3
	3/16	60.9	30.4	17.8
	1/64	181	90.6	52.9
	1/32	137	68.5	40
3/16	1/16	97.7	48.9	28.5
	3/32	78	39	22.8
	1/8	67.5	33.7	19.7
	3/16	54.2	27.1	15.8
	1/64	167	83.6	48.8
	1/32	126	63.2	36.9
1/4	1/16	90.8	45.4	26.3
	3/32	72.7	36.3	21.2
	1/8	62.7	31.3	18.3
	1/64	150	75	43.8
3/8	1/32	113	56.7	33.1
	1/16	81	40.5	23.6
	3/32	65.5	32.7	19.1

PRACTICAL TABLE OF CUTTING SPEEDS—CAST IRON

Roughing Cuts

Corresponding to different depths of cut and thickness of feed on soft, medium and hard cast iron, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

Standard 5/8-In. Tool

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft cast iron	Medium cast iron	Hard cast iron
	1/64	216	108	63
	1/32	160	80	46.6
3/32	1/16	110	55	32.2
	3/32	88.4	44.2	25.8
	1/8	75.4	37.7	22
	1/64	200	100	58.6
	1/32	148	74	43.3
1/8	1/16	104	51.8	30.2
	3/32	82.6	41.3	24.1
	1/8	69.6	34.8	20.3
	1/64	183	91.6	68
	1/32	135	67.5	39.4
3/16	1/16	94	47	27.4
	3/32	75.4	37.7	22
	1/8	64.3	32.2	18.8
	1/64	171	85.7	50.1
1/4	1/32	126	63.2	36.9
	1/16	87.8	43.9	25.6
	3/32	70.4	35.2	20.6
	1/64	156	77.8	45.4
3/8	1/32	116	57.8	33.8
	1/16	79.7	39.9	23.3

PRACTICAL TABLE OF CUTTING SPEEDS—CAST IRON

ROUGHING CUTS

Corresponding to different depths of cut and thickness of feed on soft, medium and hard cast iron, when best modern high-speed tools are used

TOOLS TO BE REGROUND EVERY 1 HOUR AND 30 MINUTES

STANDARD ½-IN. TOOL

Depth of cut in inches	Feed in inches	Cutting speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft cast iron	Medium cast iron	Hard cast iron
	1/64	206	103	60
	1/32	147	73.3	42.8
3/32	1/16	97.5	48.8	28.5
	3/32	76	38	22.2
	1/8	64.1	32.1	18.7
	1/64	194	97	56.7
	1/32	138	69.3	40.4
1/8	1/16	93.1	46.5	27.2
	3/32	72.1	36.1	21.3
	1/8	41.8	20.9	12.2
	1/64	182	91	53
3/16	1/32	128	64	37.7
	1/16	86.1	43.1	25.1
	3/32	67.4	33.7	19.6
	1/64	173	86.3	50.4
1/4	1/32	122	61	35.7
	1/16	81.9	41	23.9

DETERMINATION OF THE SHORTEST TIME IN WHICH A PIECE OF WORK CAN BE DONE USING THE DATA GIVEN IN THE TABLES

149. These tables are of course useful in determining the proper cutting speeds, feeds and depths of cuts for machining operations, but even with them it is somewhat difficult to determine THE SHORTEST TIME IN WHICH ANY JOB SHOULD BE COMPLETED.

In order to simplify this an ingenuous and valuable shop rule has been invented by Professor R. Poliakoff, by the use of which

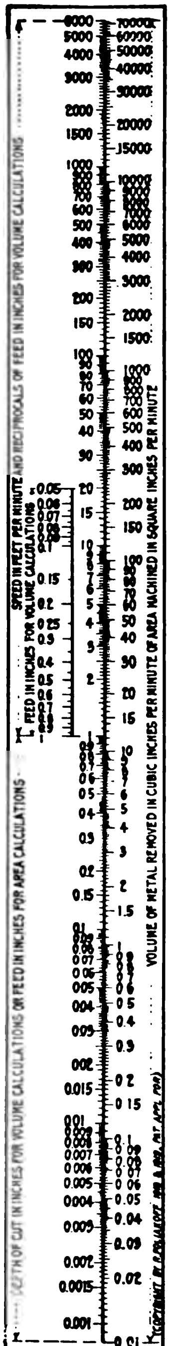


FIGURE 21.—Poliakoff Shop Rule, a Valuable Basic Setting Device, Refer to Paragraph 150

such time can be quickly and accurately determined. From it, it is possible to also determine other important factors.

150. Professor Poliakoff is the noted Russian authority on modern factory practice. He is assistant Professor Mechanical Technology, Technical Institute, Moscow, and is a well known engineer of wide practical experience. He has had charge of important Russian war contracts in this country.

His investigations and experiences in the field of production engineering have covered wide fields. He is the author of many papers on factory practice, his data being based upon scientific methods of procedure and practice.

This shop rule which I am presenting for the first time (by permission of Professor Poliakoff) has been copyrighted by him under copyright certificates 538,800 and 521,110 and he retains all rights thereunder. No one has the right to copy or publish this rule without his consent.

The Poliakoff Shop Rule

151. The use of the Poliakoff rule enables any shop man to determine quickly and accurately the different elements in his problems relating to the removal of metals which are of importance to him.

152. To Find Time Required. For instance, knowing the number of revolutions per minute—the feed in inches—the length of th work—he can immediately determine the number of minutes required to finish the work.

153. Problem 1. To find the time required to turn or grind work. Take the distance between the revolutions per minute on the upper side of the column and the feed in inches on the lower side. From the upper side select the number corresponding to the length of the work to be turned. From this number set off the distance previously taken and the result will show on the upper side the time in minutes required to turn the work.

If in taking the distance the feed is leftward from r.p.m. then read leftward to find the time, and vice versa.

Example (*a*). R.P.M. 20; feed 1/8 in.; length of work, 5 in.; time, 2 minutes.

Example (*b*). R.P.M. 30; feed 1/50 in.; length of work, 60 in.; time, 100 minutes.

154. Problem 2. To find the number of revolutions per minute if the speed and diameter are known.

Take the distance between the numbers on the scale representing the speed *in feet* per minute and the diameter *in inches* and set it off from the division marked V on the scale rightward, if the number representing the speed is to the right from the diameter number, and leftward if the number representing the speed is to the left of the diameter number. The result will show the number of revolutions per minute.

As the number expressing the speed in feet is usually larger than the diameter expressed in inches one will have to set off in most cases the distance rightward from the Division marked V.

Example (*a*). Speed, 150 ft.; diameter, 20 in.; number of revolutions, 28.5.

Example (*b*). Speed, 30 ft.; diameter 40 in.; number of revolutions, 2.9.

155. PROBLEM 3. To find speed if diameter and number of revolutions are known.

Take the distance between the number on the scale representing the diameter in inches, and division marked V and set it off from the division representing the number of revolutions rightward, if the number representing the diameter is to the right from the division V, and leftwards if the number representing the diameter is to the left from V.

Example (*a*). Diameter 6 in.; number of revolutions per min. 66.

In this case the distance between the divisions 6 and V has to be set off rightward from the division 46. The result is 72.3 in. (speed per minute).

Example (*b*). Diameter 3 in.; number of revolutions per min. 49.

The distance between 3 and V is to be set off leftward from 49. The speed is 38.5 feet per minute.

156. PROBLEM 4. To find diameter if the speed and number of revolutions per minute are known.

The method of procedure is identical with that of Problem 2; viz.: take the distance between the numbers on the scale representing the speed in *feet* per minute and the number of revolutions per minute and set it off from the division marked V rightward if the number representing the speed is to the right from the revolutions' number and leftward if the number representing the speed is to the left from the revolutions' number.

Example (*a*). Speed 180 ft.; number of revolutions 45. The distance between 180 and 45 is to be set off rightward from V. The result is 15.3 in.

Example (*b*). Speed 45 ft.; number of revolutions 90 per min. The distance between 45 and 90 is to be set off leftward from V. The result is 1.9 in.

157. PROBLEM 5. To find the volume of metal removed. The side of the rule shown on Figure 2 is used for solving another set of problems arising in machining a bar in a lathe or in grinding it in a grinder. The divisions thereon represent as follows:

The divisions on the upper side of the column rightwards from the division marked *xl* represent the speed in feet per minute and also the *inverted* feed in inches per revolution. For instance, the division marked 100 represents a speed of 100 ft. per minute of a feed of 1/100 in. The divisions on the upper side of the column leftward of *xl* represent depth of cut in inches. The divisions on the lower side of the column represent either volume of metal removed in cubic inches per minute or area machined in square inches per minute.

The application of this side of the rule can be best understood from the following examples:

Take (with calipers) the distance between depth of cut in inches, as shown on the upper side of the column to the left of *xl* and the inverted feed shown on the same side of the column to the right of *xl*. Set off this distance to the right of the division *xl* in the upper column.

Let division *x* represent this set-off distance. Select on the upper side of the column the number corresponding to the speed expressed in feet per minute. Take the distance between this number and the division *x* and set it off from *xl* rightward, if the number representing the speed is to the right of *x*, and leftward if it is to the left of *x*. The number on the lower column opposite the end of the set-off distance will represent the volume of metal removed expressed in cubic inches per minute.

Example (*a*). Speed V = 100 ft. per minute; depth of cut = ¼ in. = 0.25 in., feed = 1/21 in.; to find volume removed.

Take distance between division 21 (inverted feed) to the right of *xl* and division 0.25 in. (depth of cut) to the left of *xl* on the upper column and set it off from *xl* rightward. Take the distance between the point obtained and the number 100 (speed) on the upper column and set it off from the division *xl* of the upper column rightward; the end of the distance so set off coincides with 14.3 on the lower column, which is the number of cubic inches removed per minute.

Example (*b*). V = 40 ft., depth of cut = 5/16 in. = 0.31 in.; feed = 1/25 in.; to find volume removed. In this case the end point of the distance between 0.31 in. to the left of *xl* and 25 (inverted feed to the right of *xl*) set off from *xl* rightward will fall to the right of division 40; therefore the distance between 40 and this point has to be set off from *xl* on the upper column leftward. The number on the lower column opposite the point so received will be 6.

Example (*c*). V = 4000 ft., depth = 0.01 in., feed = 1/12 in.; to find volume removed. In this case the distance between 0.01 (to the left of *xl* upper column) and 12 (inverted feed, to the right of *xl*) is smaller than the distance between *xl* (upper column) and 4000 (speed number) and the distance between 4000 and the sum of 12 and 0.01 set off to the right of *xl* has to be set off from *xl* rightward and will give the number of 40 on the lower column.

158. PROBLEM 6. To find the area machined.

The speed in feet per minute is to be read on the upper column from *xl* rightward, the feed in inches on the same column from *xl* leftward. In order to find the area machined in square inches per minute proceed as follows: From the number representing the speed in feet per minute on the upper column set off the distance corresponding to the feed in inches taken, from *xl* leftward. The number on the upper column corresponding to the end of this set off distance will represent the area.

Example (*a*). V = 120 ft., feed = 1/30 in., = 0.033 in.; to find area machined.

Take the number 120 on the upper column; set off from it leftward the distance between *xl* (upper column) and division 0.033 (upper column to the left of *xl*). One will read on the lower column 48, which is the number of square inches of area machined per minute.

Example (*b*). V = 30 ft., feed = 1/50 in., = 0.02 in.; to find area machined.

Take number 30 on the upper column; set off from it leftward the distance between *xl* (upper column) and division 0.02 (upper column to the left of *xl*). One will read on the lower column 7.2 which is the number of square inches of area machined per minute.

Example (*c*). V = 4800 ft., feed = ¼ in., = 0.25 in.; to find area machined. A similar procedure gives 14,400 sq. in. per minute as the area machined.

It will be noticed that a short piece of the scale with divisions marked from 1 to 0.05 in. = 1/20 in. is shown a little above the

main scale. This is really the part of the main scale corresponding to feeds from 1 to 1/20 in., which feeds are shown on the upper column of the main scale by inverted numbers. But in order to be able to read feeds down to 1.20 in. (such as 0.95 in., 0.90. . . 0.065 in., 0.06 in., 0.055 in.) more accurately, this part of the upper column of the main scale has been brought out separately.

159. From the preceding description of Professor Poliakoff's slide rule it will be seen that it is a perfectly practical device, one that can be made use of in daily shop practice. The nature and extent of the problems can be solved by its use are indicated by the illustrative problems and their several examples. Used in connection with the tables of cutting speeds and feeds for various kinds of shop materials and numerous size of tools, it places in the hands of the shop man both means and information whereby the difficult problem of selecting a proper tool feed and speed can be worked through to a practical solution.

In developing this rule Professor Poliakoff has rendered real service to men in the machine building and metal working industries, for more and more shop men are searching for mechanical device to assist the thinking and mental process in connection with their every day work. It is of assistance to remember that this shop rule is an outgrowth of many investigations and an extensive experience in the field of productive engineering.

Use of the Tables

160. We must not rashly assume that we can run our fingers down these columns and simply read off these data without giving further consideration to the problems. As a matter of fact, considerations as follows do enter.

(*a*) The finished size of the forging or casting or the nature of the cut are often determining factors. For instance, the forging or casting to be turned down may have to be finished to so small a diameter that a single cut even as heavy as is shown in the tables might spring the piece out of shape.

(*b*) Or the allowable tolerances may be so close that sufficient metal should be left on for two finishing cuts and the roughing cuts reduced accordingly.

(*c*) Or the required finish may be so high grade that too heavy roughing cuts cannot be taken.

(*d*) Or THE MACHINE TOOL ITSELF may be one of an old type and not able to stand up under the strain caused by these fast speeds, feeds and heavy cuts.

(*e*) THE METAL MAY POSSESS PECULIAR CHARACTERISTICS requiring modification of these tabulations to meet these conditions.

161. If the conditions surrounding any job fall within these limitations then special changes from the tabulated data must be

INSTRUCTION CARD

DATE ________

PART ________ OPERATION ________
SIZE-TYPE OF MACHINE TOOL ________ CUTTING TOOLS ________
ROUGHING CUT ________ FIXTURES OR JIGS ________
NUMBER PARTS USUALLY PUT THROUGH AT ONE TIME ________
WORK IS TO BE IN PLACE

OPERATIONS	STANDARD TIME PER__	OPERATIONS	STANDARD TIME PER__	
1. PREPARE MACHINE TOOL.		*6. REMOVE METAL.*		
2. PLACE WORK ON MACHINE.		*7. LOOSEN & REMOVE CLAMPS*		
3. TRUE & LEVEL WORK.		*8. REMOVE WORK*		
4. CLAMP WORK-ADJUST STOPS		*9. REMOVE TOOLS, GAGES, ETC.*		
5. ADJUST CUTTING TOOL				
(a) Cutting Speed......... *(b) Feed...............* *(c) Depth of Cut.........*				

STANDARD TOTAL TIME ________
STANDARD HOURLY OUTPUT ________

THE ABOVE TIME SCHEDULE IS BASED ON CAREFUL TESTS. THEY MUST BE MAINTAINED. IF IMPOSSIBLE FOR ANY REASON REPORT CAUSE AT ONCE TO YOUR FOREMAN.

FIGURE 22.—Form for Workman's Instruction Card, Refer to Paragraph 163

provided. The case when any of the machine tools are too old and too weak to stand the strains of these heavy cuts deserve special consideration. I find the simplest plan is to make a few running tests on old or weak machines—determine what cutting speeds, feeds and depth of cuts they *can* stand and then establish a percentage of reduction on the tabulated data for it and use such percentage of reduction in figuring cutting speeds, feeds and depth of cuts on these machines.

The Standard Recurring Work vs. Non-Repetition Work

161. The standard work that is repeated over and over is simple to handle by the outlined plan. The question of determining time and output on the new and renewal jobs can be handled quite easily.

162. The "expert on standards" soon becomes an excellent judge of time required to do any job. As far as handling and set up time for the new job is concerned, he will have accumulated enough data as to time required to perform the different elements of his different jobs so that by considering the weight, size and quality of metal of the new work, he can form a quick estimate of both. The cutting speeds, feeds and depth of cuts can be gotten quickly from the tables, the data properly modified if the quality of the metal differs from the standard.

How to Get the Data into the Shop and in Use

163. First, make out "instruction cards" for jobs which will contain all information needed for these jobs. The form shown below will clearly show the method. Sometimes it is wise to put all or at least a part of these data on the workmen's blueprint.

164. In case the work is of the standard repeat character, then the foreman is supplied with an ample quality of filled out instruction cards covering each of his operations. The worker is then given one of these when he is handed his time ticket before he starts the job. He thus has before him an analysis of the elements of the job showing time required against which he can check his actual time to see if he is falling behind. If he has any protests to make against the time being too low he can bring it before the foreman who can, if necessary, call upon the "expert on standards" to prove that the work can be done in the time stated.

165. In the case of new work the foreman will call upon the "expert on standards" who will analyze the work, make any needed tests and give him the instruction card properly filled out with all data on handling time, set up time, cutting speeds, feeds, depth of cuts, standard time and standard hourly outputs.

166. In a large shop this work will be so large in volume and so important that, at first, the "expert on standards" may have to form a separate department. I emphasize the fact, however, that outside of the stenographer, every one in the department must be a capable, quick mechanic of the type that will become deeply interested in this work, and incidentally, of the type that will keep

their mouths closed tightly. As stated previously, when you have real factory men—expert mechanics—on this work, you not only will get accurate results but get them quickly.

167. Your office man will not succeed. You might as well try to have your foreman attend to your accounting or your financial affairs. And then, too, having good, hard-headed mechanics on this work will satisfy the foremen and workers for they know that these men *can* and *will* demonstrate at any time that their calculations are correct.

Tables for Cutting Speeds, Feeds and Depth of Cuts on Other Metals

168. Sometimes it occurs that a shop will handle large quantities of metals other than steel and cast iron, such as aluminum or brass or bronze, or it may be some special alloy. It is important that tables of cutting speeds, feeds and depth of cuts be made up for these. The following procedure will usually result in a rapid establishing of such tables.

169. First Step. Consider carefully the metal under consideration and compare its tensile strength, elongation, degree of hardness, analysis with the same characteristics of the different metals shown in the tables.

170. Second Step. Select a metal shown on the tables possessing the nearest characteristics to this new metal. While selecting this metal (and its tables), also make due allowance for any special characteristics the metal may possess. Be careful to note that the method of lubrication that must be used will be a factor. This will all be a matter of judgment that your "expert on standards" is well qualified to exert.

Using This Table as a Guide Then Make Some Check Tests

171. Third Step. You should select your test bars so that they will represent average sizes.

Aim to run the cutting tool at such cutting speed, feed and depth of cut as to make it necessary to regrind it at the end of one hour and a half.

Of course, however, if the job runs a shorter time than this, say 30 minutes, then heavier feeds can be taken so that the tool may be reground at shorter periods.

172. Fourth Step. Make a number of check runs using the cutting speed, feed and depth of cut that should be used according

to the table and your judgment. By observing the finish of the work and the condition of the cutting tool, you can soon determine your own tabulations.

173. Fifth Step. With a number of tabulations made at varying cutting speeds, feeds and depth of cuts, you can readily build up curves that will enable you to establish accurately tables for any metals you may have.

174. All of such important work should be done personally by the "expert on standards," much of it in the presence of the committee for, of course, it is very essential that such tables be correct. When such a regular procedure is carried out, this *can be done* in a surprisingly short time.

175. By these methods we have substituted accurate knowledge for guess-work. We have established standards that are based upon thorough tests. We know what we *are* doing. We know that what we are doing is the best that *can be done*. In other words, we have the beginning of a real "Science of Production" that will mean greatly increased output, heavy cost reduction, a high scale of wages, and large profits.

Data on Finishing Cuts—Lathe

176. The experiments on finishing cuts that have been made by Professor Poliakoff are important and bring out some general rules that deserve careful attention.

177. But it shoud be remembered that much less experimental work has been done in connection with finishing cuts than is the case with roughing. The reason is obvious, for the greater savings in time and expense are possible in connection with the removal of large quantities of metal, as in roughing on large pieces such as forgings and shafts. It will be recalled that practically all of Mr. Tayor's work was with roughing cuts.

Difference in Performance Between High Speed and Carbon Steel Tools

178. Inasmuch as the peculiar property of high speed steel is that fact that it does not lose its hardness under great heat conditions, and as high degrees of heat are not generated at the performance of finishing cuts due to the small depth of cut, therefore, as might be expected, high speed steel does not show the marked superiority over carbon steel for tools used on finishing cuts.

179. I herewith produce, by permission of Professor Poliakoff, his article on this subject.

180. Considerable attention has been given to the variation in durability with change in the cutting speed when taking roughing cuts with carbon and high speed steel tools, but very little experimental evidence has been published on the durability of these steels when taking extremely fine or finishing cuts. The paper read by Mr. E. G. Herbert before the Iron and Steel Institute in 1910 deals with fine cuts, but these were obtained in trials made in his special tool testing machine and not in a lathe. The experiments referred to in this paper were made in an ordinary lathe and under conditions identical to those prevailing in the workshop. The tests were made with the object of showing the relation between the length of surface machined and the cutting speed for a prescribed degree of tool wear.

181. To carry out these tests a short piece of steel (part of a locomotive axle containing about 0.38% carbon) about 4½ in. in diameter was selected in order to give the necessary rigidity and cutting was continued until the tool reached a predetermined bluntness. To measure the durability after the manner adopted for roughing tools, i. e., to continue cutting until the edge of the tools breaks down, was found to be impractical and to judge from the appearance of the bar lacked definiteness. The bluntness was therefore observed as the trial progressed by means of an indicator fixed in the rest immediately behind the tool (see Fig. 39). The indicator was set to zero at the commencement of the cut and pressed against the bar so that as the tool became blunt and lost its cut the radius of the bar increased by a like amount and this was shown by the indicator. The indicator was graduated in 1/2000th of an inch and the degree of tool bluntness decided upon for these tests was 3/2000th of an inch, i. e., about 25% of the depth of cut. The lathe, however, was not stopped on the indicator attaining this figure but allowed to cut until the gage indicated 2/1000th of an inch. As the exact degree of bluntness is difficult to measure when the tool is cutting, the indicator on the tool being withdrawn, was brought back to the starting point and the bar carefully measured as the saddle was slowly traversed by hand.

182. The distance from the beginning of the cut to the spot where the indicator showed an increase of 3/2000 in. was carefully measured. The indicator was then brought back to the starting point, the bar moved through 90° and the above operation repeated. Similarly the distance traversed for the indicator to show an increase of 3/2000 in. was observed at 180° and 270° to the first observation. There was very little difference between the

four measurements and the average of these was taken to represent the length machined by the tool ere it attained the prescribed bluntness. A lubricant of soap and water was used in all the tests.

Carbon Steel Tools

183. After each test the tool was reground in a universal tool grinder and an oil-stone was drawn lightly across the cutting edge to slightly round off the feather edge and prevent crumbling at the commencement of the cut.

184. Tests with Carbon Steel Tools.—Series I and II were made when taking a cut 1/180 in. deep by 1/72 in. traverse.

185. The former was carried out with a round nosed tool having a cutting angle of 80° and at speeds between 16 and 57 feet per minute; whilst the latter series was made with a broad nosed tool having a cutting angle of 85° and at various speed between 16 to 74 feet per minute.

186. As the diameter of the bar (4.6 in.) was practically the same for both series of trials the surface machined is directly proportional to the length machined and both sets are comparable.

187. Tests with High Speed Steel.—Series III*a* and III*b*, also IV*a* and IV*b* were made with tools having a cutting angle of 75° on a bar (same as used in the carbon steel trials) about 4.2 in. diameter. The tools used in trials III*a* and IV*a* were of the broad nosed type, whilst the tools used in trials III*b* and IV*b* were of the round nose type.

188. If the quality of the finish at different speeds could be represented on a diagram the latter would take a form very similar to that given for the relation between the cutting speed and surface machined. The number of trials, however, are insufficient to enable any definite conclusions being arrived, but so far as they do they generally indicate:

(1) That carbon steel tools on the cuts taken are more durable and capable of machining a greater surface than high speed tools.

(2) That the surface machined (for a prescribed degree of bluntness), particularly in the case of high speed steel tools is not constant for all speeds but varies irregularly with the speed.

(3) That the quality of the finish improves as the cutting speed decreases. At high speeds the tool appears to

pluck and tear the surface and instead of the cuttings being sharp they are frayed at the edge.

(4) That the broad nose carbon steel tool gives consistently better results than the round nose tool whereas in the high speed steel tests the reverse is the case, i. e., the best results are obtained with the round nosed tool.

189. Below 36 feet per minute the round nose high speed steel tool is generally better than the round nose carbon steel tool, but above that speed the latter tool gives the best performance.

190. At all speeds the broad nose carbon steel tool machines a greater area of surface than any of the high speed steel tools.

The chemical composition (percentages) of the high speed steel tool used in these trials is as follows:

C	Si	Mn	S	P	Cr	Wo	Ni
0.61	0.10	Traces	0.01	0.023	4.49	14.45	0.31

CHAPTER VIII

MILLING MACHINES

INCREASING PRODUCTION—REDUCING COSTS

Importance—Action of Cutter—Types—Shapes—Grinding—Angles—Lubrication—Tables of Cutting Speeds and Feeds—Fixtures—How to Increase Production

1. MILLING machines, always important factors in economical production, are growing more and more in favor as their possibilities have developed. High pressure production and war industries have increased their scope and use. Owing to their cost and the high overhead expenses that are properly chargeable against them it is especially important that a *full output* be gotten from them. The usual output is far below that that should be reached. If anyone doubts this statement let them compare *their speeds and feeds* which determine their output with those shown as possible in the tables in this chapter and they will be shown that their mills are working far below capacity.

WHAT DETERMINES YOUR OUTPUT—YOUR DIRECT COSTS—YOUR FACTORY OVERHEAD COSTS

2. Never forget that your output, your costs, both direct and indirect, are all determined by the various outputs of your different machine tools. When the outputs are as far below the standards (as they usually are), then your outputs are far below those which you *have a right to expect.* Your costs are entirely too high.

3. Therefore, the question of determining the *proper* standard hourly output is of the greatest importance.

TYPES OF MILL

4. The broad classifications of mills are plain, universal, vertical and automatic.

The Action of Cutting Metal

5. The action of removing metal by a spiral milling cutter is very different from the same operation on a lathe or planer. In the operation of the ordinary spiral mill the cutter at each revolution starts its cut upon a surface beginning with a very thin chip, the thickness of the chip increasing as the cut proceeds. The initial tendency is for the cutter to ride or slide upon the surface, this also tending to crush the metal. This brings a severe strain upon the arbor bearings and arbor support.

6. It is evident that if there be any weakness in arbor or bearings that there will result an actual lifting and sliding of the cutter until the cutter starts into the metal, this action resulting in heavy revolution marks, inaccurate work and a bad finish with possible chatter.

Heavy Arbors

7. Therefore, everything possible must be done to reduce to a minimum the effect of this sliding, lifting tendency. The arbors or spindle must be heavy, the bearings strong, arbor supports must be used, the cutters must be mounted as near the end of the spindle as possible and an arbor support placed as near the cutters as the work will allow. If the cutters must be placed near the center of the arbor then arbor supports should be placed on each side to give the needed strength. A cutter in the center of the arbor without extra support is sure to cause bad work and will chatter.

Commercial Cutters

8. Unfortunately, the manufacturers of commercial cutters seldom take this condition into account and, therefore, the holes in the commercial cutters are often not large enough to permit using an arbor of adequate size and strength. Under such circumstances it is impossible to get the full capacity out of the machine tool as the cutting speeds and feeds have to be reduced below the possible standards to relieve the strain. This results often in a reduction of from 15% to 25% in output which indicates the real seriousness of such a condition. In other words, you will need five (5) milling machines working with such cutters to do the work that ought to be done with four (4) working under proper conditions.

The Cutters

9. All cutters for roughing cuts especially, should be made of

high speed steel as the use of this steel will always result in great gains in output, this steel standing up under the heat generated far better than carbon steel.

10. Carbon steel cutters may be used for finishing cuts (great heat not being generated in these light cuts), they giving a better finish than high speed steel cutters as their cutting edge is finer.

11. It is impossible to deal fully with the proper shapes of cutters in this article. Manufacturers of cutters and milling machines publish very complete and instructive data. A few points can well be brought out.

(*a*) A cutter with teeth unevenly ground will cause chatter, hence bad work.

(*b*) A cutter ground with too great clearance will dig into the work and then spring back thus causing chatter. Increasing speed sometimes helps in this case.

(*c*) Cutters with teeth close together will cause chatter especially when run at slow speed. One tooth will take a cut, the next will slide, hence the chatter.

12. With the ordinary cutter manufactured we do not get a true cutting action with the cutting tools as in a lathe. We get, in an exaggerated form, the pressing down of the metal by the tool coupled with its tendency to slide over the metal before beginning the cut, resulting in wear and tear on cutter and machine tool and slow and bad work.

Angle of Rake

13. (*d*) The greatest fault to-day with milling cutters is the absence of "rake." The teeth should be undercut so as to give the tooth the chance to enter the metal—that is, give it RAKE. The angle of rake should be not less than 10° for cast iron and may be increased to 15° for steel. Tests by The Cincinnati Milling Machine Company show that a cutter with a proper angle of rake will remove 48% to 60% (depending upon depth of cut) more metal per horse-power minute than one without rake. Their tests showed too the great advantage of wide-spaced teeth, with an angle for spiral mill of 25°.

14. They also show that for end mills the angle of the spiral should be 20° with teeth undercut 10°. Their design of cutter prevents this from developing weak teeth.

Clearance Angle

15. (*e*) Clearance angles on cutters have an important influence

on production. Careful tests upon the material operated on must be made to determine the proper angles for clearance and these must be standardized. An incorrect clearance angle may easily reduce the output 25%. Too great a clearance angle will cause the cutter to dig into and spring out of the work thus causing chattering and a bad finish.

Use Cutter Grinders

16. For grinding cutters a cutter grinder must be used. Above all avoid over-heating the cutters during grinding. This is a very common fault and a very costly one. Standardize the cutter grinding as described under lathes and also supply plenty of cutters so as to keep the machines running continuously with the exception of the time required to set up. Under no condition allow the workman to grind his own cutters.

17. Therefore the features to remember in commercial cutters are:

(*a*) Ample sized holes for large arbors.
(*b*) Teeth with rake.
(*c*) Proper clearance angles.

Heat Treatment and Hardening

18. Again I bear upon the great importance of this subject and my observations made upon heat treatment of lathe tools apply with the same force to milling cutters. After consultation with your steel makers and proper tests, *determine upon a standard method of heat treatment* for milling cutters—train up your heat treaters, *make* them adhere to your standards, post notices in your heat treating shop giving full instructions. Do not permit the *slightest variation* from these standards.

Lubrication or Cooling

19. The greatest strides were made in the increasing the removal of metal on milling machines when the cutter and parts were flooded with a cooling fluid at the rate of 12 gallons per minute. The possible increase in cutting speeds and feeds were very great. It is evident that this continuous flooding kept the cutter and the work cool and made it possible to run at much higher cutting speed and feeds than before and, therefore, at a much higher output.

20. Of course, the conditions under which a lathe tool works and a milling cutter operates are very different. The lathe tool is constantly cutting in the metal and the heat generated by pressure of the chip against the tool is practically constant. The lubricant has but little cooling effect upon the cutting edge of the lathe tool while in the case of the milling cutter each cutting tooth in turn is not cutting a part of the time and, too, each tooth in turn is exposed *directly* to the effect of the lubricant or cooling compound and, therefore, the heat generated at high speed is carried away rapidly. This condition makes it possible to increase cutting speeds and feeds far beyond those possible when the cutter is run dry or under ordinary small ineffective flow of lubricant.

21. The lubricant or coolant also keeps the part cool. Therefore, the part will not spring when released from fixture for it has not been overheated.

The finish is also much finer.

22: You have to *flood the work* with 12 gallons of cooling compound per minute. To get the best results, special though simple devices must be designed to pump or handle this quantity of coolant so that it will not splash over the work.

Results of Tests

23. If anyone doubts the great advantage of cooling the cutter and work by flooding, the results of tests made by The Cincinnati Milling Machine Company will settle any arguments. The experimental work leading to the development of this practice of flooding milling machine work was conducted under the direction of Mr. A. L. DeLeeuw.

Tests Made by Cincinnati Milling Machine Company Flooding Work. Compare with Your Results

24. Test No. 1. Work flooded with lubricant (or coolant).

Made with spiral mill cutter, 25° angle, 3½ in. diameter, 9 teeth, 10° rake, 6 in. long, arbor 1½ in diameter.

Depth of cut, ⅛ in.; width, 5 in.; length, 18 in. Speed of cutter, 500 r.p.m. Peripheral speed, 458 feet per minute. Feed, 30½ feet per minute.

Finish good for commercial milling when surfaces are to be bolted together.

25. Test No. 2. Compared with No. 1 with cutting dry.

Cutter, same as in Test No. 1; work same as in Test No. 1.

Depth of cut, ¼ in.; width, 5 in.; length, 18 in.

Speed of cutter 87 r.p.m. Peripheral speed, 80 feet per minute.

Condition of work and cutter—after running 2½ in. the cutter showed distress. When stopped, the edges of the teeth were found to be blurred.

26. TEST NO. 3. Work flooded with lubricant (coolant).

Made with spiral mill cutter, 25° angle, 3½ in. diameter, 9 teeth, 10° rake, 6 in. long, arbor 1½ in. diameter.

Depth of cut, 0.02 in.; width, 5 in.; length, 18 in.

Speed of cutter, 500 r.p.m. Peripheral speed, 458 feet per minute. Feed, 7.23 in. per minute.

Finish good enough to polish.

27. TEST NO. 4. Work done under flood of lubricant (coolant).

Cutter, helical mill, diameter, 3½ in.; length, 6 in.; 3 teeth; angle with axis, 68°; rake, 15°; arbor, 1½ in.

Cutter speed, 520 r.p.m. Peripheral speed, 475 feet per minute. Feed, 30½ in. per minute.

Depth of cut: first one, 1/16 in.; second, 3/16 in.

28. TEST NO. 5. Work done under flood of lubricant (coolant).

A slotting cutter with sharp-cornered teeth 1 in. wide, 6 5/16 in. diameter; rake, 15°; 16 teeth; arbor, 1½ in. Alternate teeth slope in opposite directions with the axis of the cutter.

Cutter speed, 510 r.p.m. Peripheral speed, 835 feet per minute.

Cuts were taken at a depth of 3/16 in. and ¼ in.

Finish was a good commercial finish in each case.

29. TEST NO. 6. Work done under flood of lubricant (coolant).

High-feed test, gashing with a gear cutter. Cutter, 7 diametrical pitch with extra hub, 12 teeth, 3½ in. diameter, 10° rake, arbor, 1¼ in. diameter.

Cutter speed, 218 r.p.m. Peripheral speed, 200 feet per minute. Feed, 112 in. (9⅓ ft.) per minute.

Material of the same composition as for the blocks in the preceding test, in the form of a cylinder 18¼ in. long, and of a diameter representing a 30-tooth, 7-pitch gear.

The machine upon which this test was made was a 28-in. Cincinnati semi-automatic miller.

Repeated cuts were taken without any signs of distress of machine or cutter.

30. TEST NO. 7. Work done under flood of lubricant (coolant).

Same cutter as described in Test No. 6 run to destruction.

It milled 6700 in. not including cutter approach.

Equivalent to cutting 223 gears of 1-in. face, 7 pitch, 30 teeth.

Compare These with Your Own Results

31. Such results prove the case for copious flooding lubrication beyond the possibility of dispute. If you wish to know the great possibilities of this work just compare these figures with your own results on similar work. The difference will be so great as to be startling.

Lubrication of Cast Iron

32. It was found by test that the lubrication (cooling) of cast iron showed a gain on light frail parts through the keeping of these parts from getting hot and getting out of shape. This method, however, was impractical as the gritty pieces of cast iron were carried into the bearings and destroyed them.

Great Increases in Production with Present Milling Machines Possible

33. By comparing your present cutting speeds and feeds with such data and the tables which I shall presently show, it will be evident that large increases in production with your present equipment. My statement of a possible 50% gain will look small. Remember, too, that this represents milling machine practice as done to-day in the best shops.

General Facts

34. The rate of feed determines the rate of production. Therefore, the feed, while limited sometimes by the weakness of the part or the fixture—the weakness of the cutter and the finish desired, should be as fast as is allowable under the conditions.

How Long Should Cutter Last Until Regrinding is Necessary

35. It must be understood that everything is predicated upon the workman being supplied with cutters so as not to have to wait to have one reground, as such practices as the latter, which results in great increases in direct and overhead costs, are too absurd to consider.

Slow Speeds and feeds will prolong the life of the cutter, but the labor cost and overhead cost will increase.

Fast Speed. A faster speed will increase the output, but will wear the cutter faster and thus make resetting necessary oftener, which may mean a considerable loss of time.

Wear on Cutter. The relative wear on the cutter through slow or fast speed may be disregarded, for generally, if the proper proportion of speed and feed and depth of cut are maintained, then the cutter will do approximately the same amount of work.

Small Quantity of Parts. The quantity of parts is a factor. If the quantity is small then the attempt should be to have the cutter last through the milling of this lot on the first setting. Thus, if the lot is below the normal in quantity, then the speed and feed can considerably exceed those shown in the table, *provided* the cutter and the parts can stand the extra strain.

Large Quantities of Parts. When a large number of parts are to be milled then the main question to consider is the character of the set up and the time required for it. If this is simple and quick, or on operations with ample tolerances, then the cutting should be done at the full limit of possible output.

36. If the set up is slow and difficult owing to close tolerances or other conditions, then this must be taken into consideration and a speed determined upon that will not be so destructive of the cutter as to keep the milling machine down too large a proportion of the total time required for the job.

An Example

37. Suppose you have 2000 parts to mill, your usual time of milling per piece is 8 minutes, handling time 2 minutes, time required to reset, 50 minutes, number of pieces milled before resetting, 100. The total time would be divided as follows:

2000 parts, each 8 minutes' milling time.....	16,000 minutes' milling time
2000 parts, each 2 minutes' handling time...	4,000 minutes' handling time
2000 parts, requiring 20 settings at 50 minutes each	1,000 minutes' resetting time
Total Time..................	21,000 minutes

Now, let us speed up so that our milling time is 6 minutes—the extra wear on the cutter reduces the number of pieces before resetting to 50.

2000 parts, each 6 minutes' milling time.....	12,000 minutes' milling time
2000 parts, each 2 minutes' handling time....	4,000 minutes' handling time
2000 parts, resulting in 40 sets of 50 minutes each	2,000 minutes' resetting time
Total Time..................	18,000 minutes

38. This shows that you can so increase your speeds and feeds as to double your set-ups owing to increased cutter wear and yet save time and cost. To this should be added the cost of the extra regrinding.

The General Rule

39. As a general rule, it pays to use the greatest speeds, feeds and depth of cuts that can be used considering: (*a*) Design of cutter and size of hole; (*b*) Size and strength of arbor (limited by size of hole in cutter); (*c*) finish desired; (*d*) strength or frailty of part; (*e*) strength of fixture; (*f*) strength of machine tool; (*g*) method of lubrication.

These Exceptions

40. It will strike the average reader that such a number of elements, as mentioned above, as modifying any standard practice, would perhaps make all tabulations useless and yet not so, for all of these elements are apparent on their face.

41. The tables represents what can be attained under *average conditions as found in the usual shop.* Much better results will be secured if *all* of these elements are up to the *proper standards.*

42. The design of the commercial cutters is not what they should be. As stated, the size of holes is usually entirely too small necessitating the use of an arbor that is too light which causes it to spring—resulting in chattering and poor work.

43. Again, the teeth are often not undercut (without rake), thus causing a tendency for the cutters to slide over and compress the metal instead of entering it, this causing very severe strains on the work—the cutter—arbor and machine tool, and causing slow and bad work.

44. Incorrect clearance angle will cause the tool to dig in and jump out of the work, causing chattering, or, if not sufficient may make it very difficult to mill and cause unusual strains throughout.

45. I caution you to see that these conditions which are common, do not prevail, otherwise, you can have no standards—no real speed in production.

46. The strength of your arbor or spindle depends upon the size of the hole in the cutter. Arbor supports must be freely used to provide proper support for the cutters, and prevent springing. Never forget that the natural tendency of a milling cutter is to slide

over and compress the metal before beginning the cut. This action concentrates the strain on the arbor, this being far greater than is ordinarily supposed.

47. The Cincinnati Milling Machine Company has completed an exhaustive series of experiments in milling machine practice covering milling machines, milling cutters, lubrication, and standard speeds, feeds and depth of cuts that are remarkably thorough, practical and accurate.

48. Their statements relate to action of milling cutters—shapes of cutter teeth and design of cutters—their deductions as to necessary strength in the milling machine themselves, their deduction relative to lubricants, also their tables on speed, feed, depth of cuts, are proven by actual every-day shop practice to be correct.

49. Through their courtesy I present the tables showing speed, also feeds and proper depth of cuts under various conditions, these being very complete.

50. The Cincinnati Milling Machine Company has established the following facts concerning feed:

1. The first factor to consider is finish desired.
2. A feed of .035 in. to .050 in. per revolution using spiral mills—end mills or form cutters will give a satisfactory commercial finish.
3. A higher feed than .050 in. per revolution may be used to get surfaces which are bolted together and which need not be oil-tight.
4. A feed of .030 in. per revolution is proper to secure a surface that must be scraped or finish ground.
5. A feed of .020 in. per revolution will give a high finish without subsequent operations.
6. Fine feeds must be used when the cutter is small and frail.

51. The same company has determined that when modern cutters and an ample supply of coolant are used, the following cutting speeds can be safely used.

52. The speeds given below have been found by tests by The Cincinnati Milling Machine Company, and our regular factory practice, to be safe when using modern cutters and ample lubrication.

Cast Iron

Spiral Mills

Rough milling	65 to 75 feet
Finish milling	80 to 120 feet

Face Mills

Rough milling	65 feet
Finish milling	80 to 110 feet

MACHINE STEEL

Spiral Mills

Rough milling	70 to 75 feet
Finish milling	100 to 140 feet

Face Mills

Rough milling	60 to 85 feet
Finish milling	90 to 110 feet

TOOL STEEL—ANNEALED

Spiral Mills

Rough milling	50 feet
Finish milling	70 to 80 feet

CHROME NICKEL STEEL (.30 to .40 carbon drop forgings)

Rough milling	45 feet

TOBIN BRONZE

Spiral Mills with Lubricant

Rough milling	90 feet
Finish milling	125 to 150 feet

BRASS	200 feet
ALUMINUM	600 to 1000 feet

The above figures may be exceeded when all conditions of heavy machine tools, big arbors, strong arbor supports, proper type cutters and ample coolant prevail.

53. The following diagrams prepared by The Cincinnati Milling Machine Company, and reproduced with their permission, will be found very useful. By their use the superintendent and tester can determine practically any problem in connection with cutting speeds, feeds, and depth of cuts.

54. It was found possible to greatly exceed these feeds and speeds on work that was rigid, when all the conditions were right. On the other hand, if the equipment is old and the cutters of the usual type found in stock, it may be necessary to reduce them. They, however, represent a very satisfactory average under proper conditions.

55. FIGURE 23. MILLING CAST IRON WITH DIFFERENT DEPTHS OF CUT, WITH 3-IN. CUTTER.

56. This diagram (No. 23) shows the cutting speeds and feeds when milling cast iron at different depths, using a 3-inch to 3½-inch diameter cutter. The heavy line in the diagram will be noted. This is drawn vertically at a cutting speed of 70 feet per minute which represents good practice in milling cast iron. The diagonal lines represent "depth of cut."

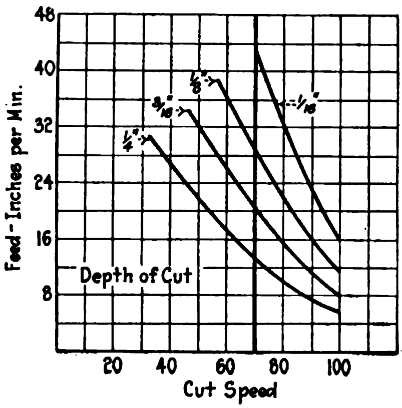


FIGURE 23.—Relationship of Feed, Speed and Depth of Cut When Milling Cast Iron With 3 in. Cutter

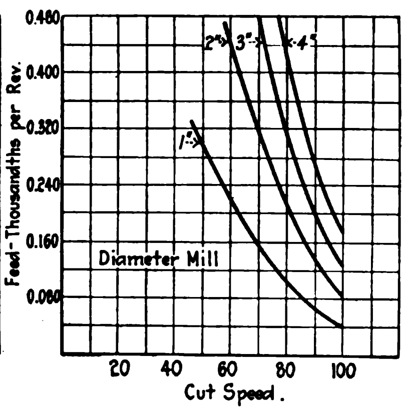


FIGURE 23.—Relationship of Feed, and Speed When Rough Milling Cast Iron With 1/10 in. Depth of Cut

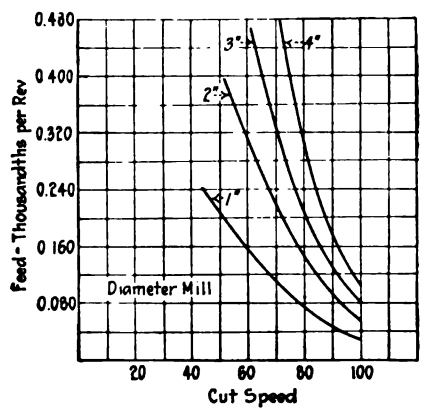


FIGURE 25.—Relationship of Feed and Speed When Rough Milling Cast Iron With Depth of Cut ⅛ in.

57. Let us take a cut ⅛ deep in cast iron, run at a cutting speed of 80 feet per minute. The curve on the diagram shows that the best rate is 22 in. per minute for 3-in. to 3½-in. diameter cutter.

58. Or suppose on another job on cast iron we determine the proper feed to be 12 in. per minute. If we adopt a depth of cut of 3/16 in. then our cutting speed may be 88 feet per minute.

59. Inasmuch as the results shown on Diagram No. 23 are limited to cutters of 3 in. to 3½ in. diameter, we must now consider results for cutters of other sizes. The following diagrams are built up for different depths of cut.

60. The curves of Figure 24 are based on USING A CUT 1/10 IN. DEEP. Roughing cuts on cast iron. The curves are for different diameters of cutters. If you have a cutter 4 in. in diameter and will run the feed at .240 in. per revolution, by reference to the diagram you will find that you can run the cutter 93 feet per minute.

61. Figure 25 shows results of roughing cuts on cast iron, using a depth of cut of ⅛ in. with various sized cutters.

For example: Using a cutter 4 in. in diameter and a feed of .240 in. per revolution we get a cutting speed of 84 feet per minute.

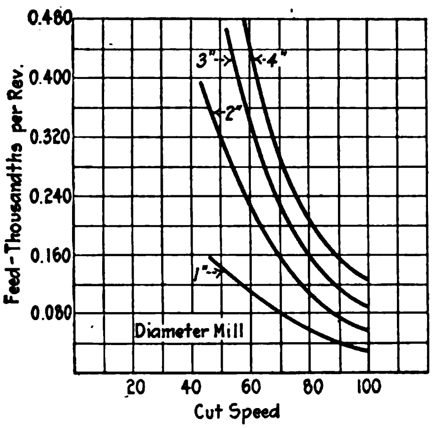


FIGURE 26.—Relationship of Feed and Speed When Rough Milling Cast Iron With a Depth of Cut 3/16 in.

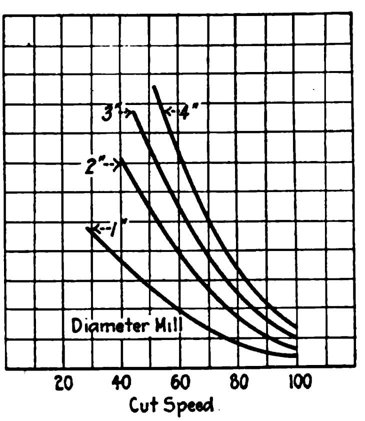


FIGURE 27.—Relationship of Feed and Speed When Rough Milling Cast Iron With a Depth of Cut ¼ in.

62. Figure 26 shows results of roughing cuts on cast iron USING A DEPTH OF CUT OF 3/16 IN., with various sized cutters.

For example: Using a cutter 4 in. in diameter and a feed of .240 in. per revolution, we get a cutting speed of 76 ft. per minute.

63. Figure 27 shows results of roughing cuts on cast iron USING A DEPTH OF CUT OF ¼ IN., with various sized cutters.

For example: Using a cutter 4 in. in diameter and a feed of .240 in. per revolution we get a cutting speed of 65 feet per minute.

FINISHING CUTS—CAST IRON

Spiral Mills

64. Figure 28 shows the proper cutting speeds and feeds for general practice on FINISHING CUTS OF 1/64 IN. AND 1/32 IN. IN DEPTH. It does not take into account the influence of the size of cutters, but will serve as a guide for ordinary purpose.

65. (*a*) Figure 29 shows the proper relationship between cutting speed and feed for CUTTERS OF DIFFERENT DIAMETER when using A DEPTH OF CUT OF 1/64 IN.

(*b*) For example: Take a cutter 4 in. in diameter with a

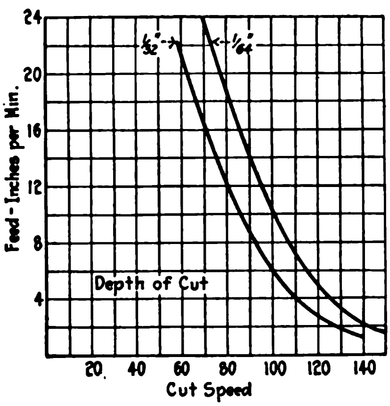


FIGURE 28.—Relationship of Feed and speed for Finish Milling Cuts 1/64 and 1/32 in. in Depth

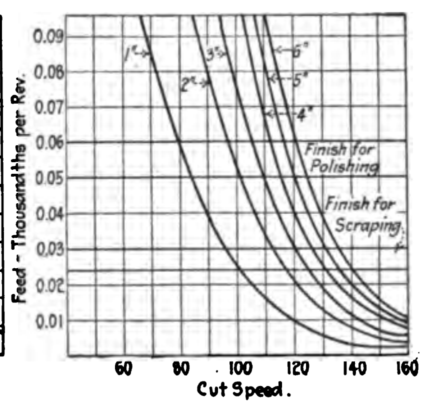


FIGURE 29.—Relationship of Feed and Speed for Finish Milling Cuts With Depth of Cut 1/64 in.

feed of .023 in. per revolution. This diagram shows that a safe speed is 130 feet per minute.

(*c*) Note especially the heavy horizontal lines drawn at feeds of .050 in. and .060 in. per revolution. Included here will be found the feeds and corresponding speed which represents the best practice on work requiring polishing.

(*d*) If finer grades of finish, suitable for scraping, are required, then use the feeds and corresponding speeds included within the heavy lines drawn at .024 in and .030 in. feed per revolution.

(*a*) This diagram shows the proper relationship between cutting speed and feed for CUTTERS OF DIFFERENT DIAMETER when using A DEPTH OF CUT OF 1/32 IN.

(*b*) For example: Take a cutter 4 in. in diameter with a feed

of .023 in. per revolution. This diagram shows that a safe speed is 120 feet per minute.

(*c*) Note especially the heavy horizontal lines drawn at feeds of .050 in. and .060 in. per revolution. Included here will be found the feeds and corresponding speed which represents the best practice on work requiring polishing.

(*d*) If finer grades of finish, suitable for scraping, are required, then use the feeds and corresponding speeds included within the heavy lines drawn at .024 in. and .030 in. feed per revolution.

Roughing Cuts—Cast Iron—1/8 In., 3/16 In. Deep Using Shell End Mills

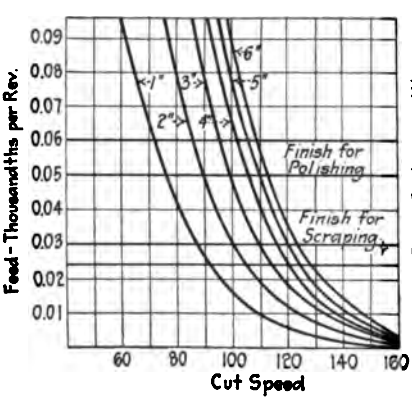


Figure 30.—Relationship of Feed and Speed for Different Diameters of Shell End Milling Cutters

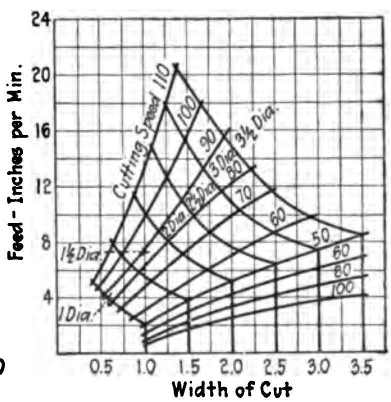


Figure 31.—Relationship Between Feed and Width of Cut for Various Milling Speeds

66. Figure 30 shows proper feed and speeds for different diameters of shell end milling cutters when operating at depth of cut from 1/8 in. to 3/16 in. There is also introduced the width of cut in Figure 31 which makes another variable.

For example: To take a cut 2 in. wide with a 3-in. diameter end mill, the cutting speed will be 75 feet per minute and the feed 11 in. per minute. If we use a 3½-in. diameter cutter to take a cut 3 in. wide, our cutting speed will be 60 feet per minute and feed 9½ in. per minute.

These results apply only to modern end mill cutters. If the older type is used, as is common, these results must be reduced by 25% to 35%.

Roughing and Finishing Cast Iron

Face mills.—Depth of cut for roughing is 1/8 in. to 3/8 in.
Depth of cut for finishing is 1/64 in. to 1/32 in.

67. Figure 32 shows curves for face mills on roughing cuts with depth of cut ranging from 1/8 in. to 3/8 in., and finishing cuts with depth of cut ranging from 1/64 in. to 1/32 in.—both for cuts which are approximately equal in width to the diameter of the cutter.

For example: At a feed of 12 in. per minute the cutting speed may be 62 feet per minute for roughing and 82 feet per minute finishing, when using a high-power face mill. If using a standard mill of highest design these figures should be reduced to 50 feet

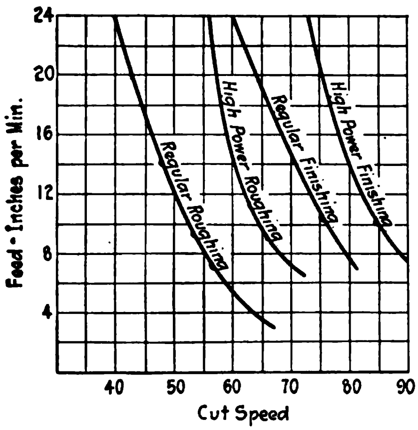


Figure 32.—Relationship Between Feed and Speed for Face Milling on Roughing Cuts

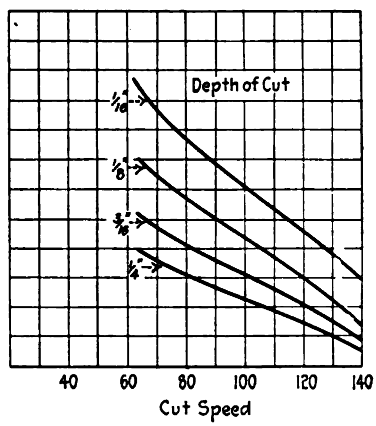


Figure 33.—Relationship Between Feed and Speed for Milling Cuts on Machinery Steel at Various Depths

cutting speed for roughing cuts and 73 feet cutting speed for finishing.

At an 8-in. per minute feed, the cutting speed for the heavier machines become 68 feet per minute for roughing cuts and 89 feet per minute for finishing cuts. When using a lighter standard mill these cutting speeds become 56 feet per minute for roughing and 79 feet per minute for finishing cuts.

Spiral Milling on Machinery Steel

68. Using flooding lubrication, and modern wide-spaced, wide-angled spiral mills with rake. Figure 33 is based on cuts taken on machinery steel with a depth of cut of 1/16 in.—1/8 in.—3/16 in.—1/4 in., using a wide spaced, wide angled spiral mill with proper rake and flooding lubrication.

Assume a feed of 8 in. per minute—the proper cutting speed for a depth of cut of 1/16 in. is 128 feet per minute; for a depth of cut of 1/8 in is 104 feet per minute; for a depth of cut of 3/16 in. is 80 feet per minute; for a depth of cut of 1/4 in. is 62 feet per minute.

Finishing cuts on machinery steel using a depth of cut of 1/64 in. to 1/32 in. under similar conditions may be taken at a cutting speed of 150 to 160 feet per minute.

If, however, the cutters used are of the common type and lubrication is of the usual limited kind, then these figures must be reduced fully 25% to 35% from the above figures.

69. Figure 34 illustrates the cutting speeds and feeds on steel castings and machinery steel.

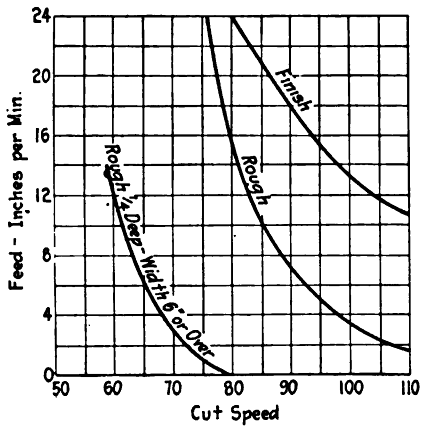


FIGURE 34.—Relationship Between Feeds and Speeds When Milling Steel Castings and Machinery Steel

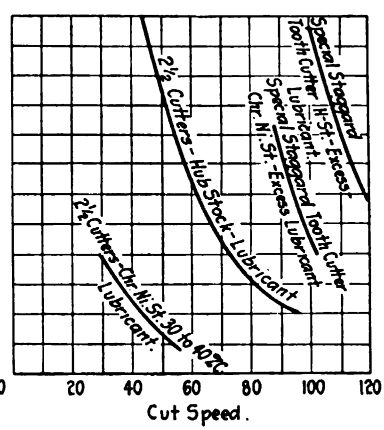


FIGURE 35.—Relationship Between Feeds and Speeds Using Modern Milling Cutters and Flood Lubrication

The roughing cuts are shown at from 1/8 in. to 3/16 in. deep, and the finishing cuts at from 1/64 in. to 1/32 in. deep—the width of cut equalling 1/2 to 3/4 of the diameter of the cutter.

For example: A roughing cut at 16 in. per minute feed will stand a cutting speed of 80 feet per minute.

A finishing cut at 16 in. per minute feed will stand a cutting speed of 94 feet per minute.

The curve at the left shows the proper feed and speeds when taking a roughing cut 1/4 in. in depth and 6 in. or more in width.

For example: A feed of 12 in. per minute will stand a cutting speed of 60 feet when using a 1/4 in. depth of cut.

Keywaying—On Machinery Steel

Stream Lubrication

70. Figure 35 is based on results obtained when using modern cutters, flood lubrication, milling nickel steel forgings 1½% N.; .30 to .40 carbon, .40 to .60 Chr., or when milling hub stock machinery steel. The diagram shows two sets of curves.

For example: With a feed of 8 in. per minute, a cutting speed of 30 feet can be maintained in chrome nickel steel, and in hub stock machinery steel a cutting speed of 73 feet per minute.

When using an inserted tooth cutter of the latest type—described by The Cincinnati Milling Machine Company—4 in. in diameter, 9/16 in. face, at a feed of 8 in. per minute, we can get a cutting speed on chrome nickel steel of 103 feet per minute.

This last example will illustrate what can be done in production using modern well-designed milling machines, properly designed and made cutters, and ample flooding lubrication.

Strength and Design of Fixture

71. Here is a fertile field for examination. In the usual shop the milling fixtures being used on standard production are of antiquated design and construction. They were never built to stand the pressure of the intense production methods of to-day, and can neither stand the strains of present standards, nor can close work be produced on them. Often, they require far more time than they should for the putting in and taking out of work, screws being used instead of quick acting clamps.

72. We are just waking up to the great waste incurred in this factor of handling time, and the new strong quick acting fixtures are *big factors* in speeding up production. It will pay to make a study of these milling fixtures beginning with those which are old and weak, and also those where the handling time is a large proportion of the total time required.

Strength of Machine Tool

73. The strength of the machine tool is a factor. If it is very old it will not stand the pace and will soon rack itself to pieces if you attempt to run it at the standard speeds and feeds.

74. Of course, the best thing to do is to get modern machines and scrap these old money eaters, but sometimes that is easier said than done. A manufacturer once said to me: "Mr. Car-

penter, the increased costs of material and labor have so strapped me that I couldn't buy ten-dollar gold pieces for nine dollars and eighty cents if I had to pay cash. I'll have to do the best I can with what I've got."

75. And great things can be done with the old machines by adapting the tables to their strength as will be brought out later.

Method of Lubrication

76. The article on lubrication has brought the great advantage of the flooding lubrication (or cooling). Few shops are fitted for this and it will take time to do it. The tables, as they stand, will be all right for cast iron—on machine steel they may require a reduction if flooding lubrication is not used. When it is used, and all other factors are up to standard, the speeds and feeds may be greatly increased.

77. As I have brought out in the chapter on Lathe Work, there are a number of important points to consider other than those of cutting speeds, feeds, depth of cuts, all of which must be handled properly before starting this work. They are as follows:

The man for testing;
The place;
The classification of parts;
The study of set-ups;
The study of handling time;
Lubrication or cooling.

The Man

78. There must be an expert tester developed, an "expert on standards." This work must not be left in the control of any one excepting a man especially selected for the work. If possible, get an intelligent ambitious foreman or assistant foreman who is a good mechanic.

79. Let him devote his ENTIRE TIME to developing this work, reporting to the superintendent. Select the best man you have. Do not, above all things, appoint an office man or one without mechanical ability. You want a man WHO KNOWS and to whom the other foremen will defer when he tells them that they can double their speeds and feeds on a particular job.

The Place

80. Give him a place for testing as far removed from the fac-

tory as possible, where he can carry out his try-outs quietly and without causing any disturbance amongst other foremen or the workers. A capable man, with these tables at hand, will work out with surprising rapidity the proper cutting speeds, feeds and depth of cuts, that will give you the greatest possible output and that will form your future standards for hourly outputs. By this plan he will lay the changes in cutting speeds, feeds and depth of cuts before the superintendents and foremen only after thorough demonstration and, therefore, there can be no disputing them.

The Classification

81. It is especially important that all the milling jobs be grouped in accordance with the type and size of miller the operations are performed on.

82. The first broad class will be the type of milling machine, hand millers, plain millers, universal millers, vertical millers and automatic millers.

83. Then under each of these classes will come the grouping of jobs or operations according to the *size* of mill.

84. After the grouping of parts then take each group (according to size of machine tool), and study it. Separate the different jobs in each in accordance with their size and the character of fixture used.

85. It must be clearly understood that the object of all this is to get all jobs or operations of a similar character that are performed upon the same size and type of tool *grouped together* so that a small number (say 15%) can be selected for test, that are representative of the balance. By testing these few and establishing the standards it thus becomes easy to calculate the standards for the rest of the groups without testing them.

86. The slow process of testing one part after another is interminable, takes too long, costs too much—this plan of classifying and grouping then will save a great deal of time and cost.

Lubrication or Cooling

87. Your "expert on standards" will also study the problems of flooding lubrication or cooling in order to determine how this system can be applied to the machine tools in the shop. The great benefits to be secured by flooding the work and cutter with 12 gallons of soda water per minute MUST be secured.

The Study of Handling Time and Set-Up Time

88. This is always a distinct problem by itself and is very important. The handling time is almost always a very large factor of the total time consumed in production. By this I mean the time required to open up the fixture, remove the machined part, place it in the box or tray, clean the fixture, then pick up a new part, place it in the fixture, tighten or clamp the fixture ready for the cut. A careful study of this problem always results in a large increase in output. The time required for the set-up is another large item that always richly repays investigation.

The Average Workman's Loss of Time

89. The average workman wastes a great lot on time on the set-up, as he is usually ignorant of proper methods. The only sensible thing to do is to determine a "standard method of set-up"—set the time required for it as a standard—and then either ***train*** your workmen to do it *within* the specified time or train special job-setters, whose sole work it shall be to set up jobs quickly and accurately for the worker. The gain in time and accuracy will far more than pay their cost.

The Handling Time

90. It is on the handling time that the great loss occurs. Work not placed at the right position (height and distance) for the operator to reach it easily, lack of skill in unclamping fixture, leisurely way of transferring the part to the box, hunting around for brush or air connection to clear chip out of fixture, wasting time in picking part out of box (badly located) and carrying it to fixture, lack of skill in putting in piece and clamping it in fixture.

91. There are still men who choose to disregard these points and regard them as "too fancy." Yet I have had literally thousands of cases where a study of the handling time has reduced it 50%. Many jobs require as long a time (or more) to handle the part as it takes to machine it.

92. Take a job that requires two minutes to handle it and two minutes to machine it, or four minutes altogether. A reduction of 50% in the handling time reduces the total to three minutes, or a saving of 25%—a saving of "one minute" does not sound very impressive, but a saving of 25% in TIME with the consequent

saving in labor costs and overhead is a BIG THING. And do not forget that your shop is full of such cases.

93. Let us never forget that 1000 working hours are made up of 60,000 minutes, and it's the way those *little minutes are spent in the shop* that determines whether that 1000 hours represents efficiency and profit or waste and loss. IT IS THE MINUTES THAT COUNT.

WHAT THE WORKERS ARE DOING

94. All that the machine-room workers are doing all over the shop is to (*a*) open a fixture; (*b*) take out part and place in box; (*c*) clean out fixture; (*d*) pick up piece and place in fixture; (*e*) clamp the fixture; (*f*) start the machine tool to cutting. Therefore, a study of all such conditions must be made.

85. It is important to understand the method of analyzing handling time for part and tool. It consists of dividing the operation, no matter how simple or how complicated, and then timing out each of these elements with stop watches. The operation of the small element can be easily and accurately timed and the tester cannot be deceived in this. Thus, by adding together all these times we get the total time. Very surprising and satisfactory results can be secured in this manner.

96. After the proper standards for cutting speeds, feeds and depth of cuts have been determined and the standards for handling and set-up time has been worked out, it becomes necessary to make a permanent record of such data which I call the standard time and output records.

97. The superintendents and foremen are supplied with copies of these. Each workman is to get a copy when he is given his job of work to do. Thus he will have full instructions and data which will guide him in his work. If he feels that he cannot reach such outputs and time, he then can protest to his foreman who will show him how to do it.

98. Thus we have a clear method of procedure when the best time and biggest output is determined properly. It becomes a part of the production schedules, is proven to the foremen, is set before the worker in such a manner that he cannot but produce in accordance with the schedule. This system means bringing up production to the highest possible point and control of the situation.

The Importance of Milling Machine Design and Its Effect Upon Industry

99. It is evident to any factory manager who has studied the trend of events in the production field and the development therein of processes that are big "increasers of production," that the design of milling machines and milling cutters is of the greatest importance.

100. The milling machine is recognized as a *"big producer,"* and everything that will increase its production is of interest to the factory man. The difficulty that the factory manager now faces is to procure milling machines so designed that they will stand the strain and stresses of modern intensified production.

101. The development of high speed steel cutters, of the newer designed cutters, heavier arbors, flooding lubrication or cooling, all make possible cutting speeds and feeds that were never thought possible a few years ago. But the milling machines of the past and many of the present will not stand up under the strain, and must be operated from 25% to 40% under efficiency.

102. The moment we say that for certain milling machines and certain types of cutters we must reduce the tabulated cutting speeds and feeds 25% to 40%, just that moment do we utter an indictment against them. There can be no room in an efficient shop for a milling machine or cutter that must operate so far under efficiency when they are operating constantly.

103. Milling machine manufacturers of the best, most progressive type, realizing that their product should be so designed and built as to get the full advantage in possible production of all of these factors of steel, cutters, lubrication, have so designed their latest types that they will perform this extra heavy duty satisfactorily.

CHAPTER IX

THE PLANER DEPARTMENT

1. There is no one department in a shop that will yield greater results in reduced costs and increased production than the planer department when proper methods are installed.

Importance of Planer Department

2. This being usually a department that initiates or starts off some of the work in a shop, it is very necessary that its output be large and steady and that the balance of the shop never be delayed because of its lack of production. Experience shows, however, that this department is seldom up to its mark in production. It is surprising to see how often serious shop delays can be traced back to a slow moving, slow producing planer department.

The Two Divisions of Planer Work

3. The problems of planer work is included in two classifications:

4. First. The *handling time* which includes the handling of the piece off and on to the planer, the setting and leveling of the work, the clamping of the work or the setting it into its fixture.

5. Second. The setting of the tools and rate of removal of metal which depends upon the cutting speed, speed of return, feed, depth of cut.

First Classification the More Important

6. The first classification of problems is the more important of the two, though this is usually overlooked. In every-day work the planer itself is cutting metal only a small proportion of the total time required to complete a job. Repeated observation has proven that in the average shop even well run, the handling, leveling, clamping of the work takes from two to three times the actual

metal cutting time. That is, in every six (6) hours you have *only two (2) hours* of actual cutting time and *four (4) hours* of down time.

Accounts for Delays

7. This condition accounts for much of the delayed shop production for, when the planers were installed, no such allowance for non-cutting time was ever taken into consideration. As a result the planer department is usually behind on its production.

Provides Chance for Savings

8. It is obvious that such conditions provide excellent chances for savings. I have myself worked out simple plans which resulted in savings of 60% to 80% in handling time. Combine this with the savings possible in speeding up the cutting speed of the planer and we have some fine economies possible. By very simple methods I cut the total time on planers on bolt frame bars from eleven hours to three and one-quarter; on frame castings from nineteen hours to five and one-half; on large castings from thirty hours to ten; in fact, the average reduction on all planer work was over sixty-five (65) per cent, and the workmen did not have to work with any greater degree of fatigue.

Handling Time—Leveling—Clamping—Fixtures

9. In dealing briefly with these subjects it may appear that I am laying stress upon many very obvious points. I can, however, assure my readers that a long practical experience in shop work has taught me that great losses of time occur through the constant neglect of just these "obvious points," a recital and explanation of which I consider important.

10. First Step. See that each workman is provided with an inexpensive but strong cabinet in which he will keep his blueprints of jobs being worked on and to be worked on, an ample supply of cutting tools already ground, an ample space for his clamps, stops, screws, parallel strips, tool lifters, paper, gages, chuck, and all special fixtures that he may need for the jobs close at hand. The usual mess around the planer, blueprints and tools stuck around amongst the castings and forgings, clamps and stops scattered everywhere, valuable fixtures laying around on the floor getting into bad condition, everything so confused as to make it almost

impossible to walk around and altogether impossible to find needed articles—such a mess is a sign of bad management. It is a simple matter to correct and good common sense at that.

11. SECOND STEP. See that the next piece of work and the proper blueprints in the cabinet are at hand beside the planer before the job on the machine is completed. Neglect of this is common and causes many hours of lost time.

12. THIRD STEP. Next consider the proper method of handling the work on and off the planer. The method, etc., to be used will depend upon the nature of the work. The one principle to keep in mind is to reduce the workman's labor and time as far as possible. Use power cranes, compressed air or electric, whenever possible. This has been well developed, and necessary information relative to the method best adapted to your conditions can be gotten from the manufacturers of such appliances.

13. FOURTH STEP. The setting and clamping of the work. This is a very important factor in both accurate and speedy production.

14. The clamping has to be done carefully. The common mistake is to clamp the work to the planer bed very firmly as though the clamping was depended upon to keep the work from slipping. This must NEVER be done, for it invariably springs the casting so that after the cut is taken and the clamps are released the work springs back and the surface is not accurate.

15. The clamping should only be firm and tight enough to keep the tool from lifting the work. Position STOPS should be used on the planer bed, set against the end of the work to keep the piece from slipping under the force of the moving tool. NEVER depend on your clamps for this.

16. The general run of shop work should be studied and a standard set of clamps devised. Angle clamps with a right angle projection at one end are preferable to the old straight clamp or stops that requires blocking up underneath. This projection will largely take the place of such blocks—is much easier to adjust and is a big time saver. The bolt holding the clamp down should *always* be as close to the work as possible—certainly beyond the center—or otherwise too much leverage is lost and the clamps must be tightened so much that they will spring the work. The clamp or stop should be as near level as it is possible to get it. The use of parallel strips brings good results. The proper holding of very thin work requires special care in clamping, and special devices are very useful in such cases.

Savings in Time

17. Fifth Step. So great is the loss of time incurred in the setting and clamping of work that a special study of this problem should be made by the superintendent and the foremen, also consulting the *workman on the job.* Don't forget the workman, for often he knows more about difficulties and remedies than anyone else. It is nothing short of amazing to see how comparatively simple changes leading to standard methods of handling and setting, standard clamps and standard methods of clamping will lead to great savings in time.

Put Standard Data on Blue-Prints

18. Sixth Step. After your standard methods of setting and clamping a job are determined then be sure to put all these data on the planer's job drawings, so that the blue-prints will not only show it to the old men but also form valuable instructions to new operators. This planer's blue-print should show (*a*) standard methods on setting for rough and finishing cuts; (*b*) the exact sequence of operations to follow, i. e., what sides should be rough cut before any finish cuts are applied so that internal strain may be relieved before making finishing cuts; (*c*) whether the casting requires any seasoning or heat treatment between rough and finish operations; (*d*) the number of pieces to be set on planer bed for any one operation; (*e*) standard clamps to be used; (*f*) standard methods of clamping including full instructions as to where clamps must be applied. This is all very easy to do and the advantage of determining these simple standards can hardly be overestimated.

Fixtures for Planers

19. Seventh Step. On any work of a repeat character careful consideration should be given to the use of special fixtures. Of course, the expense must always be considered; the work may be so simple or come so infrequently as not to justify any expense on fixtures. Yet a thorough study of the planer jobs will almost always disclose many surprising opportunities for large increases in production and reduction in costs through the using of simple planing fixtures. The setting-up time will be very greatly reduced and more accurate work produced. Fixtures must be made so that the bed of the planer, for its entire length and width, may be fitted with parts, thus allowing for planing parts in multiple. So,

too, three or four or even six tools may be used at one time cutting on the different parts.

20. A well-designed fixture will often prevent springing of parts that otherwise might prove troublesome. Never forget that a bad planing job will cause trouble and expense all through its progress through the shop. Simple fixtures can often be devised that will permit of using a roughing and a finishing tool together in one head, this doing away with changing tools and making a fast method of doing the work.

Gages

21. On work of a standard character planing gages are often useful. These gages are the exact shape (cross-section) of the finished part. They are placed in such a position with relation to the part to be planed (e. g., at the end) that they serve as an exact guide to the planer's hand and eye. He so guides his tool that by using this gage as a guide he will plane down the different surfaces to correspond exactly to this gage which, being constantly before him, serves as an excellent guide.

Cutting Speeds and Feeds

22. Eighth Step. Just as in our consideration of lathe work we find that the life of the tool—its cutting powers—are limited by the heat generated and conveyed to it. A planer's tool (on roughing cuts) is cutting deep in the metal for a comparatively long period without any cooling medium. Therefore, the same cutting speed cannot be used on a planer as on a lathe. Of course, the use of high speed steel has been a factor in permitting big increases in cutting speeds.

23. The shapes of the tools have been well determined by the planer manufacturer and they will give very clear information to anyone asking. It is necessary to standardize your tool shape, and a careful study of your work will lead to shapes well adapted to meet your particular condition. Ingenious tools and tool holders can be devised. Always use very stiff holding devices.

24. Again, do not permit the planer hand to grind his own tools and thus have their valuable tool shut down for considerable periods. Such practice is stupid. Provide your planer hand with plenty of tools, and have them ground for him to your standard shapes.

Feeds

25. Use as wide a feed as possible. The average will run from

⅛ to ¼ inch. The wider the feed the fewer the strokes, hence the saving in time and labor costs.

Table of Cutting Speeds

26. The data following are presented with the permission and by the courtesy of The Cincinnati Planer Company. The figures represent the best practices in some of the highest grade shops of to-day. The character and conditions of the work will prove the determining factor whether or not these speeds will have to be modified, but they can be used as an excellent guide.

Cast iron, roughing..........	40 to 50 feet per minute
Cast iron, finishing...........	20 to 25 feet per minute
Steel castings, roughing......	30 to 35 feet per minute
Wrought iron, roughing......	30 to 45 feet per minute
Steel castings, finishing.......	20 feet per minute
Wrought iron, finishing......	20 feet per minute
Bronze and brass............	50 to 60 feet per minute
Machinery steel..............	30 to 35 feet per minute

THE DETERMINATION OF THE SHORTEST SPACE OF TIME IN WHICH A PLANER JOB SHOULD BE DONE CALLED "THE STANDARD TIME" FOR THAT JOB

The Elements Making Up Total Time of a Job

27. The main elements that make up the total time required to complete a job are:

1st. The time required to handle the piece;
2nd. The time required to set the piece;
3rd. The time required to remove the metal.

28. As a general thing the time required to remove the metal is the first to receive attention. Yet it is a fact that on the average planer job the handling and setting time will require more time than that taken in removal of the metal. A careful study of the handling and setting time is necessary. On the face of it, it is not good sense to pay thousands of dollars for a big planer and then have it standing idle four hours or more out of every eight, while the work is being gotten ready.

The Cost of This

29. When you figure the loss of your planers standing idle half

their time you can get an idea of these losses. These losses consist of paying your worker's wage for ever hour it is down—in addition, all the overhead charges, which are large in the case of so expensive a machine tool, with its original investment, its large floor space occupied, all mounting up each hour.

30. Consider the saving that I effected when I cut my planers in use from 19 to 13 and doubled the output. First, I saved workmen's wages on six planers, which at 60c. per hour equalled $32.40 per day. To this should be added the saving in overhead. The saving was over $65 per day or almost $20,000 yearly, without considering the saving in doubling the output on the other 13 planers which was, of course, very great. This shows the importance of this work.

31. I have found when investigating such jobs that there was no excuse for the loss of so much time even though the job may require a careful set up. Much of it comes from the (*a*) new work not being on hand when the old work is completed; (*b*) workmen waiting while some one looks up the blue-prints for the new job; (*c*) tools not ready; (*d*) foreman and workmen wasting time coming to a conclusion as to tolerances which are not shown on the blue-print; (*e*) a necessary fixture that has been allowed to lie around on the floor subjected to bumps and rough treatment found to be in need of repairs when it is needed. As one of my old foremen said when first going into a department run on this usual plan: "It's just one fool thing after another," and that is a good description of the situation.

The Analysis of These Elements

32. We must take any job and divide it into its simplest elements or parts. We then must time out each of these elements; then study it carefully to see how it can be improved. Once determined, then that method becomes "THE STANDARD" and must not be deviated from by anyone unless and until another better standard is tried and approved by those in authority.

33. First. As stated before, we assume that there are on hand for the new job all needed blue-prints, cutting tools, clamps, stops, supplies of tools of all kinds, any special fixtures in good repair, instruction cards.

34. Second. The new part to be operated on is to be in place, ready for handling.

35. Third. The preparation of the planer for the new work.

This must be timed out with a stop watch. Right here the committee watching the test will begin to note the lost time. The workman will take too many trips for his clamps and tools. He will not carry this work through to the best advantage. A little thought and a standard practice can be evolved that will save much time.

36. FOURTH. The hoisting of the work to planer bed and placing it thereon. This sounds like a simple thing yet it is surprising how many points will be considered. Is the work placed in the best position for quick handling? Is the method of hoisting the best? Is too much time lost in adjusting chains or ropes? Can a magnet hoist be used to good advantage?

37. FIFTH. Shall the work receive the roughing and finishing cut on the one side while it is set, or shall the two opposite sides be roughed out before any finishing cuts are taken? We must not forget that when the tool, in its roughing cut, removes the outer skin of a casting, the internal stresses that were set up when the casting cooled then come into play and may cause a serious warping. It, therefore, may be necessary to rough cut opposite sides before applying any finishing cuts. Sometimes a casting or forging may require seasoning or heat treatment between operations. At this point, too, a study of the design may help by leading to changes in patterns which may avoid much of this trouble.

38. SIXTH. The leveling of the work and the adjusting and tightening up of clamps and stops has already been dealt with. At this point will come many time-saving suggestions—the usual design of clamps and method of adjusting is primitive. For important jobs special clamps can be devised that will save a great deal of time—such clamps to be considered in the same class as a special fixture.

39. At this point the timing by a stop watch should be especially exact. Test after test should be made until the best standard method is evolved with the clamps as they are. Make note of time-saving clamps and make another test and study when any new designs are out.

40. Here, too, should be considered the matter of any special time-saving fixtures. The tool designer, superintendent and foremen together should decide whether any fixture would pay for itself in saving of time and costs.

41. SEVENTH. Adjusting heads and placing tools therein, so as to give proper cuts. This should be timed out carefully and standard methods adopted which must be held to.

42. EIGHTH. Adjusting planer speeds to standard. This to be de-

termined by reference to tables and to be timed out and a method and time adopted as a standard.

Removal of Metal

43. Ninth. This to be done in accordance with tables as described carefully timed out and a standard cutting speed and feed adopted as standards for the particular part. While the tables of speed will serve as a guide, still these may have to be varied to suit the characteristics of the particular metal, or the degree of frailty of the part which may make heavy cuts impossible, or the age and type of the planer itself which may make the big cuts impossible owing to its weakness.

44. All of this must be determined with care, and the full data for the particular piece under test set down.

Stoppage of Planer to Replace Dulled Tools

45. Tenth. Watch this carefully. See that plenty of ground tools are on hand; that the dulled tools are placed where they will be collected and reground; that the fresh tools are adjusted quickly. Time all this carefully and set your standards.

46. *Do not* let your workmen grind their own tools, no matter who argues in favor of it. The idea of allowing a big planer, costing thousands of dollars, to stand idle while some workman, who cannot know how to do the grinding properly, meets a group of others around the grinders, talks baseball and growls at the company—finally grinding his tool to suit his idea (which usually differs from all the others), is too far out of date to even discuss. The only reason I mention it so often is because it is so common.

Loosening and Removing Clamps and Stops

47. Eleventh. Standardize the practice and get the stop-watch time as standard.

Removal of Work from Planer Bed

48. Twelfth. Standardize the method and get the stop-watch time as permanent standards.

49. Thirteenth. Removal of tools; placing them—clamps, fixtures, blue-prints—in the proper place in the cabinet. The used tools to be placed in a special used tools compartment from which they may be gathered for regrinding.

The Form to Use Upon Which to Record Tests

DETERMINATION OF STANDARD HOURLY OUTPUT

DATE..

PART..OPERATION...

SIZE-TYPE OF MACHINE TOOL..................................CUTTING TOOLS............................

NUMBER OF PARTS USED ON TEST NO.1.............TEST NO.2............TEST NO.3...........

BLUE PRINT NO...

TIME REQUIRED TO	TEST NO.1		TEST NO.2		TEST NO.3		STANDARD TIME	
	TIME	NOTES	TIME	NOTES	TIME	NOTES		
(1) *PREPARE PLANER*								
(2) *PLACE WORK ON BED*								
(3) *TRIM & LEVEL UP WORK*								
(4) *CLAMP WORK-ADJUST STOPS*								
(5) *ADJUST CUTTING TOOLS*								
(a) *Cutting Speed*.......... (b) *Feed*.......... (c) *Depth of Cut*..........								
(6) *REMOVE METAL*								
(7) *LOOSEN & REMOVE CLAMPS*								
(8) *REMOVE WORK.*								
(9) *REMOVE TOOLS, GAGES, ETC.*								

STANDARD TOTAL TIME ______

STANDARD HOURLY OUTPUT ....

SIGNATURES.......................................SUPERINTENDENT

PRESENT AT TEST.......................   ....FOREMAN

....FACTORY SYSTEM

Use Back of This for Special Notes.

NOTES ON 1	*Use This Side for Special Notes on the 9 Elements.*
NOTES ON 2	
NOTES ON 3	
NOTES ON 4	
NOTES ON 7	
NOTES ON 8	
NOTES ON 9	

Figure 36.—Form Used to Determine Standard Hourly Output

RETURN SPEED

50. The best return speed of a planer will vary between 80 to 100 feet per minute on the average. The increasing the return speed on planers is a favorite hobby with many men, but this should be approached carefully. It's no small matter to stop and reverse this heavy mass of metal. Too often it is tried on old planers with results far from satisfactory. When this is attempted the very first thing to do is to lighten your pulleys. Their high speed of rotation stores up inertia just as a fly wheel, and the amount of power required to reduce them is surprising. However, do not worry over your "return speed." Get busy on the handling of work, cutting down lost time, increasing your cutting speeds and you will have your hands full of work that will bear splendid results.

OLD MACHINE

51. If your machines are old you must approach the problem of increasing your cutting speed carefully. Don't put such a strain on an old machine as to rack it to pieces. Use your judgment and modify your standard cutting speeds to suit the machine and change pulleys accordingly.

MODERN PRACTICE

52. Modern practice is toward the variable speed reversible motor-driven planer. With these the cutting speed or the return speed can be varied independently or both can be varied together.

MULTIPLE TOOLS

53. It also is leading toward multiple tools and heavy cuts. It is now common practice to use four (4) heads cutting at one time. In some cases two (2) or three (3) tools are used in one head.

SPECIAL DEVICES

54. Every device possible is used to reduce to a minimum time lost in handling, setting up, clamping work. Ingenious fixtures are devised to save time and improve accuracy.

STUDY OF CASTING AND FORGINGS

55. Careful studies of casting and forgings are being made

to ascertain if any dimensions can be reduced in the original pattern so as to save paying for the metal and paying for taking it off.

Training of Workmen

56. Any production man knows that a good planer hand is a jewel. On planer work there is required an amount of skill that is surprising. Owing to such conditions it is folly to take the ordinary mechanic and put him on the planer job without training. The amount of work he will spoil and the amount of time he will waste will astonish you. You have got to train him. The fact that you have the planer data standardized makes this very much simpler. If you have no special department for training then you should delegate this training job to some bright, ambitious assistant foreman. He must have a regular method of procedure and a regular system of reports which will be given in detail on the chapter on training. It should be noted here that special fixtures always simplify the question of getting men who can do this work for a lower skilled class of labor can be used when they are developed.

CHAPTER X

THE DETERMINATION OF STANDARD HOURLY OUTPUTS, ON JOBS REQUIRING A SHORT MACHINING TIME

1. THE most important and the most difficult jobs upon which "standard hourly outputs" must be established are those which require only a short machining time with a relatively long time for handling the part and the jig or fixture.

USUALLY NEGLECTED YET MOST IMPORTANT

2. The big majority of jobs in American shops fall into this class; yet I find that chief attention has been centered on that work wherein the machining time is long. Therefore, I give in this chapter the results in increased production and cutting costs of a policy of investigation and determination of the "shortest space of time in which a job can be done" as applied to such jobs. Many years of practical experience have proven that this almost unexplored field is even fuller of possibilities of big savings than the other upon which attention has been chiefly centered.

THE SMALL SAVING

3. The one BIG THING to remember is that here it is that "THE SMALL SAVING IN TIME COUNTS." If you are getting 60 parts per hour, or one per minute, from a machine tool, and can increase this output to 90 per hour, or one every 40 seconds, you have saved "only 20 seconds" (it doesn't sound like much), but you have increased that output 50% and have greatly reduced costs. If a foreman had proven to you that he could cut the time on a long job from one hour to forty minutes, you would be greatly impressed. This saving of *20 seconds* deserves the same consideration.

4. When my organization cut down the time on one part on one hand screw machine from one in every two minutes and **ten**

seconds to one in every one minute and twenty seconds, the gain of fifty seconds would not impress a manufacturer very greatly. But let us see! The first output was 28 per hour, the latter was 40 per hour. We had 40 operators on this job. This meant that in one day of nine hours we formerly got 27,320 off the job daily, and under the new rate of output we got 39,600 daily with the same operators and machines. The saving was very great.

5. Other results which were secured, the fundamental basis of which was the "determination of the standard hourly output," showed records fully as good as these.

6. Such results have been secured in many other cases and all go to prove that the "determination of the shortest time in which each job can be done" is of *vital importance* in all jobs requiring a short machining time so that proper "standard hourly outputs" can be set.

The Basic Principle Underlying the Plan

7. We must keep in mind that *time!* TIME! is the one big element to consider. It makes no difference how that time may be spent—how it may be wasted—*you,* Mr. Manufacturer, pay for that time. For instance, your machine tool may be operating at high efficiency, but your operator may be wasting many minutes in handling the part and placing it in the fixture; this may often mean a waste of 20% of the *entire* time for the job. You pay for it. Or, on a job requiring two minutes to handle and two minutes to machine, the worker may lose 40 seconds because he has to use slow working screws instead of quick-acting clamps to force the part up against the stops; this means a 12½% loss of time and money. You pay for it. A short time ago I found five jobs where there was a loss of 15%, due to the fact that on three of them the 15 operators had only five brushes with which to clean out the chips from their jigs and waited on one another for them. On the other two where we blew out the chips with compressed air we did not have sufficient connections, and those we did have were continuously falling on the floor; the 20 operators losing time in stooping down to pick them up. Not much to bother about there you say? Only a little shortage of brushes and a few pipes falling on the floor? Well "we paid" for 15% loss of output on 35 operators for this little neglect.

8. FIX FIRMLY IN YOUR MIND THAT ON THESE "SHORT TIME JOBS" IT IS THE LITTLE THINGS WHICH SAVE THE MINUTES AND THE SECONDS THAT COUNT.

SAVINGS COME FROM ELEMENTS OTHER THAN MACHINING TIME

9. Now it is obvious that on such jobs the savings to be effected will come not only from the saving in machining time, by crowding the machine tool to its limit, but also by cutting down the operators' time in HANDLING THE PARTS AND HANDLING THE FIXTURE, JIG OR CHUCK.

THE THREE MAIN ELEMENTS TO STUDY

10. These three main elements are:
- (*a*) The handling of parts from box to fixture or jig, and placing it therein.
- (*b*) The handling of the fixture or jig, operating it, cleaning fixture, clamping part therein and unclamping it.
- (*c*) The time required to machine the part.

THE STUDY

11. Let us take a common case of a short time job on a milling machine. The time consumed may be divided as follows: (Assuming that operator has removed his last part from fixture.)
- 1st. He reaches over to box, picks up fresh part and carries it to fixture.
- 2nd. He places part in fixture, carefully putting it against proper stop.
- 3rd. He fastens part into place by screws or clamps, closing fixture or jig.
- 4th. He machines the part, watching the finish secured.
- 5th. Stopping machine tool, he opens fixture and unfastened the part.
- 6th. He removes part from fixture or jig.
- 7th. He carries part from fixture to box or tray.
- 8th. He brings machine tool back to starting position.
- 9th. He cleans out fixtures or jig for next part.
- 10th. He gages a part occasionally to see that tolerances are adhered to. By examining finish and gaging part he will determine whether cutting tool is becoming dulled.

12. Any man can see that while, on a 30-minute or one-hour job of machining, these elements would not be such important factors, still on a job that takes two minutes and ten seconds or four minutes, these various factors will make all the difference in the world in your output. Remember now, that I had only to save 50 seconds on one job in order to jump the daily output on these parts with the same machine tools and operators from 27,320 to 39,600, and then remember the importance of "SAVING TIME."

THE COMMITTEE

13. Before beginning this work get together your investigation committee, including the superintendents of production, of assembly, of inspection, the foreman whose job is being tried out, the expert tester and head of factory systems. Two of these men should have stop watches and an ample supply of forms (preferably typewritten) in order to make copious notes.

CLASSIFICATION

14. The jobs should first be classified, so as to reduce to a minimum the number of parts to be tested. The parts must then be subjected to the following analysis and tests.

15. The one point that I wish to bear upon with special emphasis is that the testing of jobs MUST NOT WAIT FOR NEEDED IMPROVEMENTS. Time all elements as THEY ARE and then re-time them when the improvements are effected. Start with existing conditions—improve later.

DISCUSSION OF THESE TEN ELEMENTS AND ACTION TO TAKE

16. 1ST ELEMENT. OPERATOR REACHES OVER TO BOX, PICKS UP FRESH PART AND CARRIES IT TO FIXTURE.

Procedure. Place all boxes or trays near to operator and at height which will prevent necessity of stooping over. Study this question of location of box or tray carefully. Any man who compels operators to continuously stoop over to the floor for parts on short time jobs ought to be put at a machine tool himself and be compelled to stoop over say sixty times per hour for nine hours while doing a hard day's work otherwise. The next day he would order in racks or small platforms that would bring the work up to the level of the operator's position. He would find that not only is he losing a full ten seconds in this stooping over, but as the

day moves on and his back began to ache he would be losing nearer twenty seconds at each stoop.

17. Aside from the humanitarian standpoint any manager who doesn't take into consideration the comfort of employees and freedom from fatigue while working, belongs to the dark ages. He still thinks that the human being has the characteristics of one of his machine tools. As a matter of fact, this question of freedom from fatigue is a big factor in efficiency.

Action to Take

18. Therefore, install racks or platforms that will bring the work up to the level of the position of the operators and place it where he or she can reach it with the least possible loss of time. Then make new tests to determine the proper time under these new conditions.

Saving Handling Time

19. In one investigation my examining committee found that in the case of our hand-screw machines, milling machines doing short operations, drill presses doing work requiring jigs on multiple operations, that a very considerable saving in time could be made by the operator reaching over and taking the part out of the tray and placing this part directly alongside of the machine, doing this while the *machine itself was being operated* on one of the *longer operations* which gave ample time for the operator to make this movement. Then when the operation was completed the operator, opening the jig, removed the part, placing it *not* in the tray, but by the *side of the machine* and immediately put in the jig the part which was then lying alongside the machine. Starting machining operations the operator would wait until one of the long operations was begun which would give them time to pick up the finished part alongside the machine and reach over and place it in the tray and then pick up another unfinished part and placing it directly alongside the machine. Thus, it was possible to eliminate this portion of the handling time entirely from the calculation of the total time required, for it is apparent that the handling of the part in and out of the tray was done while the machine tool was operating. This saving on these operations averaged not less than eight per cent of the total time and was as profitable as it was simple.

20. It is important that accurate studies be made by getting

stop-watch time required for such movements under the *conditions as they exist* even though they be not favorable. Set the results of these tests down as your present standards. Then improve conditions later and re-time the jobs.

2ND ELEMENT: HE PLACES PART IN FIXTURE CAREFULLY PLACING IT AGAINST THE PROPER STOPS

21. Here enters the question of design of fixture. It is so designed that part can be slipped into place easily and quickly? Many are so designed that double or triple the time really necessary is consumed while a thick-fingered operator places the part into position. The tool designers do not always take these extra thick, awkward fingers into consideration when designing a jig or fixture.

22. Put down on the report the results of the study of this element so that it may be considered later.

23. Carefully time out this element as it exists, placing this on the records. If any change in fixture be made then make further tests after the improvement is in effect.

3RD ELEMENT: HE FASTENS PART INTO PLACE BY SCREWS OR CLAMPS CLOSING FIXTURE OR JIG

24. Here again is the question of design of fixture. Is part brought up against the stops by quick acting positive clamps or by time consuming screws? The latter is always a time waster and should be avoided wherever possible. A quick acting fixture or jig is a great time saver. Insecure methods of holding parts are great scrap makers.

25. Put down on the report the results of the study of improvement of this element so that they may be considered later.

ACTION TO TAKE

26. Carefully time out this element under the existing conditions, putting the data on the records as your standards.

27. If any time-saving changes are made then retest this element after changes are effective.

4TH ELEMENT: HE MACHINES THE PART, WATCHING CAREFULLY THE FINISH SECURED

28. At this point enters the element of using the cutting speed,

feed, depth of cut that is the highest allowable. These can be determined from the tables given. There are, however, certain other factors to consider.

29. (*a*) Is the part of sufficient strength to stand heavy cutting speed, feed and depth of cut without getting out of shape?

Can any redesign of part alter a bad condition?

If not, what modification in cutting speed, feed and depth of cut are necessary?

30. (*b*) Is fixture itself strong enough to stand the strain?

If not, can any redesign make this possible?

Under existing conditions what modifications of cutting speed, feed and depth of cut are necessary?

31. (*c*) Is flooding lubrication or the old method of insufficient supply being used? Try out the flooding method and note improvement.

32. (*d*) Will machine tool stand up under the strain of these fast heavy cuts?

If not, what new type will?

Is it advisable to purchase new machine tools for this purpose?

33. If machine tool is too weak then what modifications of these cutting speeds, feeds and depth of cuts must be adopted so as to get the highest possible output from the present machine and yet not ruin it?

34. Make your notation on these items after examining part and fixture and machine tool and making such tests as may be necessary. Leave these for future action and tests.

Action to Take

35. Determine your best cutting speed, feed and depth of cut considering all these conditions and then make your tests for time and output, adopting the results as the standards.

36. When any improvements are made in parts, fixtures, or machining tools, then retest and establish new standards.

6th Element: He Removes Part from Fixtures

37. My observations under "2nd Element" will cover fully this point.

38. Test and time out this element under the existing conditions and adopt the results as your present standards.

39. If any improvements are made then make new tests, new time outs and adopt new standards.

7TH ELEMENT: HE CARRIES PART FROM FIXTURE TO TRAY

40. My observations under "1st Element" cover this fully.

41. Test and time out this element under the existing conditions and adopt the results as your present standards.

42. If any improvements are made then make new tests, new time outs and adopt new standards.

8TH ELEMENT: HE BRINGS MACHINE TOOL BACK TO STARTING POSITION

43. Test and time this out and adopt a standard for this element to keep down possibility of wasting time. Don't allow machine to "cut air" any more than is necessary.

9TH ELEMENT: HE CLEANS OUT FIXTURE OR JIG FOR NEXT PART

44. This appears to be a small thing, but many valuable seconds can be wasted searching for brushes or air connections as I have already described.

45. Give your operators every facility for this.

46. Test and time out this element and establish your standards.

10TH ELEMENT: HE GAGES A PART TO SEE THAT TOLERANCES ARE ADHERED TO. BY EXAMINING FINISH AND GAGING PART HE WILL DETERMINE WHETHER CUTTING TOOL IS BECOMING DULLED

47. It is well to establish the frequency with which parts should be gaged by the operator to prevent causing too much scrap. He should be advised how many parts the cutting tool should produce (on the average) before being reground and instructed to watch finish and gage the parts with especial care toward the end of this cutting period when scrap is most liable to occur.

48. The gaging should be tested and timed out and an allowance made as a standard for this work.

49. Reports of such a character are of great importance. They must be kept in proper shape. They can be typewritten, especially during the early period of the tests so that changes can be easily taken care of. Use good strong paper. This can contain the results of the tests in time and output and also the comments covering any improvements in procedure or fixtures, etc., to be made and retests to be made later. I have always found it to be a material advantage to have "the whole story" concerning any one part

on one sheet. In some cases, I use the reverse side for comments. I give herewith a form which will be modified to meet any special conditions.

50. Provision is made for three tests—each having any change

STANDARD HOURLY OUTPUT

DATE ____________

PART ____________ PRODUCT ____________

OPERATION ____________ SIZE & TYPE MACH. TOOL ____________

CHARACTER AND NO. OF FIXTURE ____________

CUTTING TOOLS ____________ LUBRICATION ____________

NUMBER OF PARTS USED ON TEST NO. 1 ________ TEST NO. 2 ________ TEST NO. 3 ________

PRESENT AT TESTS

TIME REQUIRED	TEST NO. 1		TEST NO. 2		TEST NO. 3		PROPER STANDARD TIME	
	TIME	NOTES	TIME	NOTES	TIME	NOTES		
(1) TO HANDLE PART FROM BOX TO FIXTURE.								
(2) TO PLACE PARTS IN FIXTURE								
(3) " FASTEN " & CLOSE "								
(4) " MACHINE PARTS								
(5) OPEN FIXTURE AND UNCLAMP PART.								
(6) REMOVE PART FROM FIXTURE.								
(7) HANDLE PART FROM FIXTURE TO BOX.								
(8) BRING MACH. TOOL TO STARTING								
(9) CLEAN OUT FIXTURE.								
(10) GAGING PART								

TOTAL..............................

STANDARD HOURLY OUTPUT....................

Signature......................Superintendent

......................Foreman

......................Factory System.

FIGURE 37.—Form for Recording Standard Hourly Output, Refer to Paragraph 50

briefly noted in the proper column. From these the proper standard time is calculated. From the total standard time is determined the "standard hourly output." See Figure 37.

CAN THE WORKER KEEP UP THE PACE

51. During the tests the committee will also determine whether or not the average worker can keep up this speed on a full day's

run. It is, of course, necessary to make proper allowances for the fact that the average worker can not equal for a full day's run the output of the output study man, which is made on a comparatively short one. However, the important point is to consider the character of the work, and the type of the machine tool used, for on some machines it is possible for the operator to closely

THE FOLLOWING NOTES COVER COMMITTEES DECISIONS ON THIS JOB

NO. 1-HANDLING PART FROM BOX TO FIXTURE = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO. 2-PLACING PART IN FIXTURE = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO. 3-FASTEN PART & CLOSE FIXTURE = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO. 4-MACHINE PART = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO 5-OPEN FIXTURE & UNCLAMP PART = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO. 6-REMOVE PART = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO. 7-HANDLING PART FROM FIXTURE TO BOX = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO. 8-BRING MACH. TOOL BACK TO STARTING

NO. 9-CLEANING FIXTURE = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

NO. 10-GAGING PART = WHAT IS DECIDED?

WHO IS RESPONSIBLE?

FIGURE 38.—Form for Recording the Decision of Committees in Regard to Jobs, Refer to Paragraph 51

approximate the results of such tests for a full day's run, owing to the fact that the machine itself needs but little attention after the work is placed in the fixture. See Figure 38.

52. Consideration must also be given to the very important point that if the work is highly subdivided and specialized, then the operator will soon acquire an almost unearthly skill in production of such parts and will beat the record of any tester.

Don't Wait for Improvement

53. Again I caution against the tendency to wait for improvements before determining the standards. Don't do it. It will take too long.

54. Establish your standards of hourly output upon the *existing conditions*—make note of advisable improvements, order improvements made, follow them up, and *when finished* then make a new test, and new time out and establish new standard hourly outputs.

Follow Up the Improvements

55. Put this "following up of improvements" under the charge of your head tester and require monthly reports of progress. They will come all too slowly under the best of conditions.

Selecting the Job

56. Naturally the committee will first attack those jobs upon which the cost is highest and delays most serious. It is well not to attempt to cover too much ground at first. Any conscientious committee will grow very enthusiastic on this plan when they once try it out and see the results.

The Providing of the Operator at all Times with Ample Supplies of Both Tools and Parts

57. The importance of providing the operator with ample supplies of parts and tools is so apparent that it would seem almost unnecessary to mention it but yet, as a matter of fact, this lack of parts and tools is a condition that is much more prevalent than is usually imagined.

58. A study of the time that the machinery is down in the shop (that is idle and performing no mechanical operation) will be found upon investigation to be a surprisingly large percentage of the total time and, as will be brought out later, there is hardly any study of shop conditions that is more profitable.

59. This constant supplying of all parts to the operators is one of the chief functions of the stock routing and stock tracing work. It will pay any manager who doubts my statements to go into the shop and stand in one department for several hours and note just how many operators are either short of material or else working very slowly in order to make their jobs last due to a bad system of supplying parts. The stock routing and tracing should take care of this.

Study of Jigs, Fixtures, Etc.

60. As shown in the analysis of the ten (10) elements, this proves to be one of the most profitable studies that the committee can make. Case after case will be found where a jig or a fixture is not of the proper strength or is not properly designed to give the best results, this being due nine times out of ten to lack of cooperation between the tool designing department and the manufacturing division. The tool designing department generally has the fault of adhering to its own ideas regardless of the opinion of the manufacturing division and is usually inclined to design its jigs, fixtures, etc, too light for the rough handling that the average operator gives it. As a consequence of this the repair bills are heavy, the jobs are often shut down and the work is incorrect.

61. Time and again the practical men on the job suggest improved methods of designing the tools that will make the operation of handling very much quicker than is found in the particular tool. Therefore, all of these suggestions should be carefully noted.

How to Quicken Up a Slow Job

62. I have found again and again that upon operations which cause the greatest trouble in the shop the quickest way to overcome the difficulty was to get my committee to make a special study of the jigs or fixtures on the job with the object of quickening production by improving these facilities, and I have found almost invariably that I could get the results desired through this very simple method.

Study of the Set-Up

63. On jobs requiring a set-up a study of this is of importance particularly where the set-up requires so long a time as to be a considerable factor in the production.

64. Ordinarily, the length of time required for the set-up determines the minimum number of parts to be sent through at any one time on any one operation. By this I mean that if a set-up requires several hours that, therefore, the number of parts sent through as a minimum should be great enough to absorb the cost of this two hours' set-up without appreciably affecting the total cost. If the set-up time is short then this does not become so important a consideration.

65. Of course, at times it is impossible to adhere to such a rule, but it will always be found very wise to make a special study of the jobs which require a long time to set them up. If conditions are such as to make it impossible to send through large quantities of such parts then the set-up should be studied at every angle in order to determine methods by which this set-up time can be reduced. I have known many cases where the set-up time was considerably in excess of the time required to machine up the number of parts that the management thought was adequate, and in many cases this set-up time instead of being charged against the actual flat cost of the job was absorbed in overhead which gave an incorrect idea of the cost of bringing through such parts.

66. Therefore, these jobs should be studied with special care and as many parts should be brought through on one set-up as may be possible.

The Actual Set-Up

67. It will often be found that the set-up on a large number of jobs is so similar that a determination of standard time required for set-up on one job will serve as a basis for the accurate estimating of the standard set-up time on the balance.

Special Men for Set-Up

68. It is often advisable to have special men to set-up the jobs on the different machines. These men tend to certain large groups of machines in order to keep them set-up in the proper manner at all times. Where the volume of work is large enough to justify it, this action will be found to be a great time saver as the average workman does not know enough to set up his tool efficiently and, consequently, takes much more time than he should and also causes much more scrap.

The Establishing of Set-Up Time—Making the Test

69. The output study man is now ready to begin the set-up of work, being watched by the committee. Again, I issue the caution that alterations in existing tooling should not be made. Suggestions are to be considered and if good are to be adopted, but changes, no matter how advantageous, must be considered as a proposition *for the future* for, if the testing is stopped in order to make some changes in the existing tooling, the whole procedure

is delayed indefinitely, the committee "grows cold" on the investigation and it takes a long time to get the job started up again. Therefore, "stick to the existing tooling."

70. The output study man is presumed to have all of his tools before him and begins his set-up. You will find that at once the committee begins to make their suggestions. One fault after another is discovered and one short cut after another is developed. As the set-up continues the clerk will take these important notes as directed by the superintendents, placing the data upon proper forms which will be shown hereafter. As the work proceeds the committee will adopt a standard for each movement made, each of such movements being properly timed with a stop watch.

71. Such a study, therefore, determines a standard set-up, and after this is gone through with the set-up is torn down and then gone through with again according to the determined standard method, the time being carefully kept by a stop watch and noted down in order to have the standard.

The Place to Make Tests

72. As stated previously the proper place to make these tests is in a room removed from the factory. The possible savings are so large and the advantage of this method so great that there can be no dispute about it. The cost and trouble of moving a machine tool to the testing department for a week amounts to nothing.

73. The results will be so advantageous to the company that no report of the tests can be allowed to leak out until the company has determined upon a policy which will permit of the use of such data with a minimum of labor dissatisfaction.

74. It is clear that this method of analyzing a job into its elements, testing and timing out each element, and thus determining a "standard hourly output," places the question of production upon a *solid foundation*. You thus have *real* data—actual facts—to base your future operations on. Facts *far* removed from the usual "guess-work standards."

75. After you have secured a lot of data on the time required for each of these elements, you are then in a position to abandon further testing and time-outs for you can, by referring to such records, secure data that will enable you to accurately place "standard hourly production" upon any job, new or old.

CHAPTER XI

DETERMINATION OF STANDARD HOURLY OUTPUT FOR BENCH WORK AND ASSEMBLY

The Difficulties—Results from Analyses—Best Methods of Determining Standard Hourly Output

1. When it comes to determining the standard hourly output for bench workers and assemblers we have entirely different conditions. Here the elements of human skill is the big factor. After an assembler has been on a difficult job for a year or two his movements become largely automatic and he can go through these operations with a skill and quickness nothing short of astounding. A test with a "try out" man on any but the simpler job is almost useless for he, unless he has had a long experience, cannot hope to equal the operator in speed.

2. There is such a variety of conditions in assembling work that it is difficult to lay down any specific rule that is applicable to all cases. The assembling of articles can be divided into two groups.

(1) The assembling of articles of a standard character, in which the work is repetitive.

(2) The assembling of work of a special character, in which each job differs from the other; and which requires specific instructions to enable the assembler to do the work.

3. The only effective method of accurately determining the standard hourly output is as follows:

4. First Step. First consider the job carefully—analyze and separate it into its simplest possible elements, i.e., divide the total assembly into as large as possible a number of its smaller assemblies.

5. Always keep in separate classifications these sections of the total assemblage which are the most difficult and which require the closest work.

6. Also arrange carefully the placing of the different necessary parts and tools so as to enable the operator to go through each small sub-assembly with the least possible movements.

7. Second Step. On any difficult assemblage job it, upon analysis, will be found to be made up of a large number of small easy operations and a comparatively few difficult ones.

8. The smaller and less important parts of the whole job must be tested out thoroughly by methods to be described—the various times and the standard hourly outputs being determined for each.

9. Third Step. Then attention is centered upon the difficult portions of the job, one at a time. Each is studied carefully and those elements which *make* it difficult are thoroughly analyzed. Very often it will be found that slight changes in design of parts will eliminate much of the difficulty. But where no changes can be allowed, then a test for standard hourly output should be made upon each of these operations.

10. It is often wise to make use of the skilled operator upon such tests of the difficult sub-operations, watching him carefully to see that he keeps up at least a fair speed. Inasmuch as the operator is testing for you only a small component of the whole assembly, he is at sea concerning the time he would *like* to take and, when watched carefully, will be forced to give a fair result. Thus, the time and the standard hourly output is determined for each of the difficult sub-operations.

11. Granting that you do not get the best that the operator *can* do on these items still, when you consider those *simple elements* upon which you *can* get reliable data you will usually find these such a large proportion of the *whole* assemblage that results on the *difficult elements*—even though not the best—will not materially affect the whole calculation.

12. Fourth Step. Thus, the results of these separate analyses and tests when added together give you the required "standard hourly outputs" on any assemblage job, be it difficult or easy.

Materials—Inspection—Supplies

13. To the assemblers the critical factors are the securing of parts that are properly inspected and up to the gages, and getting ample supplies. This statement might seem superfluous, yet every production man knows how badly the average shop falls down on these two points. Many of the great failures in munition companies is attributable to these two factors.

14. The question of "inspection" is too big a one to be treated here. However, I cannot emphasize too strongly the *absolute*

necessity for parts coming to the assembling department, within the allowable tolerances. The amount of time lost in an assembling department through the necessity of filing, grinding, scraping of parts to fit whereas they should have come through "up to the gages" is incredible. It all comes from that old attitude on the part of the superintendent and inspectors of "Well! It's good enough," and "It's a crime to scrap these parts." What are tolerances established *for?* If they are *right* then *stick to them* through thick and thin and bear down without mercy on the superintendent, foremen and operators that are the cause of the variation from the tolerances.

The Workmen Must Produce Work Within Tolerances

15. Remember—workmen will produce as good and accurate work as you *force* them to do, and they will always do just as poor work as you *allow* them to do. And they are past masters in the art of finding out how far they may go in slipping through bad work.

16. The extent to which this extra work is done in the average assembling room is not generally understood. If you want to appreciate its seriousness, then just stand in front of a difficult job or two for several hours and note that the assemblers have to do to the parts to get a fit. No work is more wasteful nor costly. The correction of such difficulties always results in an astonishing increase in output.

Shortages of Parts and Small Tools

17. One of the most amazing and most costly difficulties experienced in assembling departments is the shortage of parts. Nothing retards work as does this. This subject will be covered in the chapter on Stock Routing and Tracing. It is not difficult to overcome, even though so general. There must always be an adequate supply of parts on hand for each assembler. The same statement must be made in regard to the small tools needed by him.

Location of Parts

18. Inasmuch as assembling is mainly a question of personal skill coupled with quick and accurate movement it is evident that the placing of parts close to the hands of the assemblers is a matter of great importance. He must *not* be compelled to look around

and search for his parts, stopping his work in the meantime. They must all be *right at hand* where he can get them with a minimum of effort.

22. In cases where heavy work is assembled, and it is not done by the progressive assembly method, it is very important to study where the large and the small parts are to be located. Moreover, standardized racks can be used for the smaller parts and exact location studied out for the large parts so that there shall be a minimum of handling and re-handling. Tools must likewise be placed close at hand.

Arrangement of Machine Tools Needed

23. The proper arrangement of machine tools such as drill presses, small punch press, etc., is another matter of importance and big savings can be made by arranging them properly.

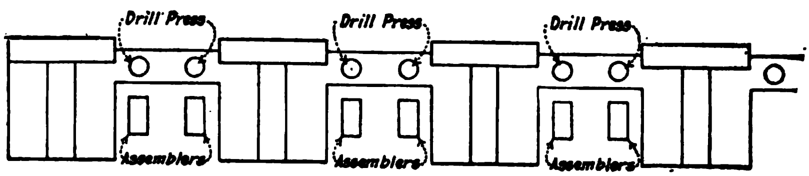


Figure 39.—Example of Rearranging Drill Presses to Suit the Needs of Assemblers

An Example

24. As an example, I give you the following data, which is one of my experiences. In one shop there were 12 assemblers on an important piece of work, and these assemblers were along the bench facing the light (the worst possible position).

25. Their operations required drilling and tapping, the drill presses being grouped together in one end of the room. When any of the assemblers were ready to drill and tap the holes, they took the work in their hands and carried it over to the drill presses. Naturally, there were always three or four assemblers around the drill presses, and this gave them an excellent opportunity to waste time. There were not sufficient drill presses but this did not worry them any. "If the company won't buy enough drill presses, why should they worry or hurry"—and they didn't.

26. The job was rearranged as in Figure 39.

27. You will note that the benches were changed so that the light came in over the shoulders of the assemblers. Down the center of each projecting bench was a space in which the assembler could keep his unassembled parts, with ample room for another tray to hold the parts as they were being assembled. This made it possible to remove the finished parts, and keep up the supply of unfinished parts, so as not to interrupt him.

28. The drill presses were then arranged along the side of the assemblers, it having been necessary to purchase a few additional drill presses. Thus, it was possible for the assembler, by turning around, to use a drill press which was always ready for him. As a result of this, the output from the same number of men was increased over 40%.

29. It is very important to note that a study of such a situation must be made by the committee appointed for this work, and dependence must not be entirely placed upon the head of the assembling department, for he, though thoroughly in earnest, very often becomes blind to existing conditions, and can not appreciate the opportunities to save time.

30. THE ESSENCE OF PROPER, QUICK, LOW COST ASSEMBLING IS "*time*"—AND EVERY EXPEDIENT MUST BE ADOPTED TO SAVE *time*.

THE ACTUAL PROCEDURE OF DETERMINING STANDARD HOURLY OUTPUT IN ASSEMBLING

31. FIRST STEP. We will assume that a keen study has been made of inspection, getting ample materials and small tools, proper arrangement of machine tools and benches and that all bad practices have been overcome. Keep in mind that a written record must be kept of the results of each of these steps. See Figure 40.

32. SECOND STEP. Select a number (say ten) of the most difficult, most costly, and most tardy jobs in the assemblage of one selected product to begin with.

33. THIRD STEP. Determine the minimum of each that should be assembled to insure a good test, then get at least 50 of each of the parts going to make up the sub-assemblage, selecting them at random. Then gage up each of these parts to be certain that they are all O. K. If not, then a most rigid inquiry should be made and all such parts in finished stores must be reinspected and reoperated. The test work must *not* go forward until the parts are up to gage.

34. FOURTH STEP. The whole sub-assembly operation must now be analyzed—separated into the *largest possible number of small*

operations. The object is to take a difficult assembling operation, and by so sub-dividing it, reduce it to a certain number of simple operations and a certain number of difficult ones. My invariable experience in both heavy and light work that those that are the most

DETERMINATION OF STANDARD HOURLY OUTPUT - ASSEMBLING

DATE..............................

SUB-ASSEMBLY.................................. PRODUCT..............................

LIST OF PARTS REQ'D..

.... PRESENT HOURLY OUTPUT..............................

PRESENT AT TEST..

NAMES OF TESTERS..

NO. OF PARTS USED ON - TEST NO. 1.............. ON TEST NO. 2.............. ON TEST NO. 3..............

ANALYSIS ON SUB-ASSEMBLY	TEST NO. 1		TEST NO. 2		TEST NO. 3		PROPER STANDARD TIME	
	TIME	NOTES	TIME	NOTES	TIME	NOTES		
1- *INSPECT BASE*								
2- *DRILL COM. HOLE*								
3- *FILL COM. HOLE*								
4- *COVER WITH GAUZE*								
5- *MILL SLOT #4*								
6- *DRILL HOLE #6*								
7- *COVER WITH GLUE*								
8- *APPLY FELT*								
9- *PRESS FELT*								
10- *PLACE H 37*								
11- *STAKE H 37*								
12- *FINAL INSPECTION*								

TOTAL TIME.............. PER..........

STANDARD HOURLY OUTPUT

SIGNATURES.............................. SUPERINTENDENT

.... FOREMAN

.... FACTORY SYSTEM

FIGURE 40.—Form Used in Determining Standard Hourly Output on Assembling Jobs, Refer to Paragraph 31

difficult, finally resolve themselves into about 12 per cent (or less) difficult elements and 88 per cent simple and easy ones.

Problem Is Simplified

35. After this is done, it is obvious that the problem is much simplified. The time and standard hourly output can be quickly and safely determined on the 88 per cent of easy operations and the close attention can be centered upon the 12 per cent difficult

ones. Even if an error be made upon the difficult ones, it is not serious.

Is This too "Red Tapey?"

36. The average production man may say that all this is too much trouble. He says, "Simply make a try out of the whole job and let it go at that." I tried this latter for years and it *will not do* when applied to the big difficult jobs. Your men will "cheat your eyes out" if you do. Time studies with a machine tool to do the work is child's play compared to the same work on assembling.

The Value of This Analysis

37. These analyses have a further decided value. They almost always lead to a further and finer subdivision of the sub-assemblies with excellent results. Again, too, if ever you go to progressive assembling, with its wonderful possibilities, you *have* to start with just such an analysis.

38. Fifth Step. The Written Record. Keep in mind that everything *must be recorded*. Not in a hap-hazard manner on scraps of paper, but in a regular methodical manner by a capable man. Remember that you will be dealing with the real fundamentals of the business and you cannot be too careful.

39. You can work out a form suited to your particular work and have it mimeographed. Letter-sized sheets with perforated holes in the top for a top binder are good. You can have printed forms of course, but these merely mean delays, cost, and a multiplicity of printed matter on hand. Besides, you will want to make changes as time goes on. But, whatever you do, *have regular forms* and make a permanent record of every move.

41. Sixth Step. We are now ready for the tests. There are present the manager of works or general superintendent, the superintendent of assembly, the foremen of the job, the tester, and one of the skilled workers who is ambitious and trustworthy.

42. The inspected parts are ready. The sequence of tests upon the subdivision of the assembly are shown in the form—parts and tools are arranged to be most convenient to the operator.

The Start

43. The start is made upon the simpler operations. I have often found it wise to have the tester first go through with it and then

the workman. Keen observation will on these easy jobs tell whether or not you are getting a fair test. The timing should be done by two men with stop watches.

Setting the Standards

44. After each test is made the conditions and results are discussed and a fair time and standard hourly output is determined, keeping in mind always that allowance must be made for fatigue of the worker. These data are placed on the form and are a permanent record.

The Difficult Jobs

45. The difficult and delicate jobs present a more serious aspect. You cannot hope to get full speed out of a green man, no matter how skillful a worker, for in assembling, even the most delicate work becomes practically a subconscious action on the part of the worker and he can reach a great speed without realizing it. But this requires time and much practice.

Using the Skilled Worker

46. In such a case you use one of the best workers on the job. You cannot expect him to show his best speed, but he will usually do well enough with the eyes of the superintendent upon him. And, too, he finds it difficult to figure how slow or fast he *should* go for his old landmarks have been removed by the division of the job into small units. By using common sense and judgment you can get good results. Even though he does beat you it does not amount to much in the sum total. Thus you determine the time and standard hourly outputs on the difficult sub-assemblies.

The Final Results

47. You, therefore, have all your entries on the sheet showing time and standard hourly output for each sub-division. By taking your total time you can figure your standard hourly output for the entire assembly.

The Possible Sub-division

48. Before using any one analysis be sure to examine it carefully to see if you cannot rearrange it so as to permanently sub-

divide the former assembly by possibly adding together a few of these small units and so make perhaps three or four sub-assemblies out of the original one.

The Instruction Card

49. From such an analysis is built up your permanent "instruction card" for such jobs. This card must contain the full informa-

INSTRUCTION CARD-ASSEMBLING

DATE ....

SUB-ASSEMBLY .... PRODUCT ....

PARTS NEEDED ....

ANALYSIS OF SUB-ASSEMBLY	STANDARD TIME PER 100 PARTS ASSM.	
1. INSPECT BASE.	2 MIN.	
2. DRILL COM. HOLE.	20 "	
3. FILL " "	15 "	
4. COVER WITH GAUZE	6 "	
5. MILL SLOT #4.	7 "	
6. DRILL HOLE #6.	10 "	
7. COVER WITH GLUE.	4 "	
8. APPLY FELT.	4 "	
9. PRESS "	4 "	
10. PLACE #37.	8 "	
11. STAKE #37.	5 "	
12. FINAL INSPECTION.	9 "	

ON ABOVE BASIS THE STANDARD HOURLY OUTPUT OF 25 OPERATORS WILL BE 1500 ASSEMBLIES PER HOUR.

REPORT TO SUPER. IF FOR ANY REASON THIS OUTPUT CANNOT BE MAINTAINED.

Figure 41.—Form for Instruction Card for Assembling, Refer to Paragraph 49.

tion on each job so that a new workman can study it and rapidly get a proper conception of how the work is to be done. The form of Figure 41 will illustrate the idea.

Adaptation to Heavy Work

50. The same method and principle will apply to all assemblage

whether it be heavy or light work. I have applied them to the building of huge bank vaults—doors and frames weighing 80 tons—to big safes, to cash register work, adding machines, small fuzes, optical instruments, delicate lens work, in fact, every variety.

51. They always bring the desired results. When you are through, you KNOW FOR ALL TIME what your *standard hourly output* should honestly and actually be on each assembly job. You have firmly built this important foundation for your future work.

Methods of Assembling

52. The new methods of progressive assembling applied by myself to various classes of work have produced such surprisingly good results that I shall deal with it in a separate chapter. It is well worth any manufacturer's serious consideration if he has sufficient of a standard output for the shortening of time and lowering of costs have always been very great.

Assembling of Special Contracts

53. In the assembling of special contracts of large size the following plan will prove useful.

54. FIRST. Before this work is started, a survey must be made of the material situation so as to be certain that every part is on hand or at least *will* be when needed.

55. If the parts are heavy, a careful study of their proper location on the assembly floor must be made so that they can be assembled with as little moving as possible.

56. The foreman and sub-foremen of assembly should go over the assembly also the detail drawing in full before they ever start so that they will "know the job" before they begin.

57. All the parts must be checked up with the drawings for proper dimensions before a start is made. Nothing is worse than to suddenly come upon an important part that is not up to dimensions and that must be made over before work can proceed.

58. All small parts and small tools should be placed in boxes and then placed in movable racks near the job so that nothing may be overlooked or lost.

59. It is often well to explain to the skilled workmen the nature of the work—the particular points that must be watched.

60. By adopting such a common-sense plan (and it is by no means as common as you might suppose), the work will move forward speedily and at low cost and the finished product will be satisfactory.

CHAPTER XII

INSPECTION

Its Value as a Cost Reducer—Importance from Quality Standpoint—Authority Necessary—How to Determine the Percentage of Inspection to Apply

1. THE question of inspection deserves more attention than it usually gets. It is usually thought of as an expense that must be endured. Yet, proper inspection will prove to be a *money saver* if handled rightly.

ITS COMMON-SENSE OBJECT

2. Inspection of parts coming through the machining division must insure that these parts, when they reach the assembling department, are accurate—within the tolerances—of the proper quality.

3. At this point the money-saving side of inspection looms up. Never overlook the tendency of the workers to grow careless—to produce work that will pass or "get by" no matter how inaccurate it may be.

4. Factory experience proves that the average workman will not trouble himself to produce good work unless he is forced to do it. It is an axiom that "the workman will produce just as good a class of work as he is forced to do—he will produce as bad a class of work as he is allowed to do." And they are uncannily wise at finding out just how far they can go in turning out work not up to standard without getting caught.

5. Of course, in cases where men are paid by piece work or premium or bonus, proper inspection must be made or the men in their eagerness to earn as much as they can, will rush through parts regardless of quality.

HOW INSPECTION SAVES MONEY

6. Proper inspection insures production of parts up to the

standard. When these parts reach the assembling department they are quickly and accurately assembled. The output of the finished article is high. But when the parts reach the assembly not within tolerance, then troubles and costs begin to mount up. A part to be filed at this point, another to be peaned and stretched at that point, a hole off center, a hole requiring hand reaming or a lathe operation on the part! Such conditions wholly upset the regular production of an assembling department and result in a product that is not uniform and may cause trouble with customers.

7. If you want to find out how general is this condition try out a little common-sense plan. For one week have every operator in the assembling department who finds any parts that require such extra work lay one of these parts aside as a sample, fastening to it a tag describing what he would have to do to it to bring it to size. This is usually an eye opener and will lead to many a change for the better.

8. Have your assembling department report such cases for several months. Then get after each one and straighten it out, and you will see big improvements.

Assembling Department Inspection

9. The assembling department inspection is of equal importance. A careful system here facilitates the assembling of the final product and insures that, when it goes to a customer, that he or she will be a "satisfied customer." And nothing in all business is more important than the "satisfied customer." A long list of *dis*satisfied ones will cost you far more than any little inspection department.

Final Inspection

10. In many large concerns the final inspection of the finished product is removed from the authority of the factory management and placed under the control of the sales department. This is an excellent idea for it insures the product getting a thorough looking over before shipment from the standpoint of the customer. The factory never likes this plan, but it is good for them.

The Authority of the Chief Inspector

11. The basic principles upon which all good inspection is built up is that THE CHIEF INSPECTOR'S AUTHORITY TO REJECT PARTS MUST BE ABSOLUTE. The superintendents of production cannot be per-

mitted to question it. He must be responsible only to the factory manager or chief superintendent and this chief of his must stand by him. Nothing is more destructive to getting through good work than to override the ruling of the chief inspector upon the appeal of a superintendent who sings that old song, "It's a shame to throw such good work away," etc., etc. It's a shame for him to produce it in the first place and he and his men must be made to produce it up to the standards. If *any* thing must be done then change the standards and the tolerances. But do not permit bad work to pass.

Inspection of Raw Materials

12. The inspection department should watch this carefully. They should have all the specifications and the needed facilities for testing the important materials. Nothing is more troublesome

RAW STORES INSPECTION

DATE ____________

MATERIAL-KIND ____________ SIZE ________ QUANTITY ________

ORDER NO. ____________ FROM ____________

SPECIFICATIONS CALL FOR MATERIAL TO PASS FOLLOWING TESTS:- ____________

PASSED ____________ REJECTED-CAUSE ____________

QUANTITY REJECTED ____________

SIGNED CHIEF INSPECTOR ____________

Figure 42.—Form for Reporting Inspection of Raw Materials, Refer to Paragraph 13

or costly than to find that a great quantity of parts have gotten into the factory and in process of manufacture that are only then found to be of defective materials.

13. This system of tests should be carefully worked out into standards. If the factory has not the proper facilities such as, for instance, the testing of tensile strength of materials, then often nearby colleges can be used. But, above all, *take no chances on bad materials getting through the shop into finished product.* A good reputation built up by many years of earnest effort can be well nigh ruined by a few big shipments of goods containing defective materials. A few dollars saved by not inspecting raw materials may cost many thousands later. A proper system of inspect-

ing and reporting on raw materials can be easily worked out. Reports must be made out on every lot. See Figure 42.

14. The form showing rejection should go to purchasing as well as stores so that they can immediately advise the producers to whom the rejected material is to be returned.

Inspection of Work in Process

15. First. Study the parts and select for first attention those which are the most essential and which have the closest working points, and need the closest tolerances.

Second. Study each one, operation by operation, and determine what operations must be held to the closest tolerances.

Third. Consider the type of machine tool that these operations are performed on so as to judge properly of the probability of there being a variation in dimensions. For example, parts coming from punch presses—punching or forming dies—or from automatic screw machines or other automatic machines or drill presses, will be duplicated approximately so long as the tools do not wear appreciably.

On the other hand, parts coming from a lathe or a boring mill, etc., may show greater liability to variation.

Determining the Percentage of Inspection

16. Considering these factors of types of tools and close tolerances necessary, it must then be determined for each operation on each part whether the inspection shall cover 100%, 50%, 20%, 10% or no inspection at all. Adopt such as the standards and never deviate therefrom.

O. K.'ing of Time Tickets and Scrap Records

17. All workmen's time tickets must be approved by the inspector. Careful records must be kept of the scrap and weekly reports made to factory manager and superintendent showing when any scrap occurred. Any excessive amount of scrap must be reported at once so that an immediate investigation into the causes may be started and the scrappage stopped.

18. The inspection report of scrappage should be checked against stores department's scrap on hand and scrap sold.

Gages

19. Gages should be inspected and checked for accuracy at

regular periods. Be sure to have enough gages to properly cover each job.

20. On jobs requiring very close inspection I have found it to be advantageous to change the operator around to other jobs during the day. Close inspection is very tedious and even a good inspector is liable to make mistakes during the latter part of the day. A change around to another job helps them.

21. The cost of inspection may well be added to the direct cost of the part wherever this is possible. Of course, the "inspection cost" must be kept separately in the cost department.

22. Good inspection is necessary—it is a real money saver. It should cover just as much ground as is necessary and cover that efficiently. A careful sensible analysis of the subject will make it possible to restrict the expense within proper limits.

CHAPTER XIII

THE "PROGRESSIVE METHOD" OF MANUFACTURING

Its Effect on Cost Reduction—The Machine Tool Survey—Progressive Machining—Progressive Assembling

1. THE progressive method of manufacturing represents the latest developments in production and has opened up the greatest possibilities yet developed for increasing production, lowering costs, maintaining an even flow of parts throughout the shop, reducing the amount of system needed, reducing working capital in the shop to a minimum.

2. This has been evolved and worked out by me with my assistants collaborating and applied with thorough success especially to the manufacture of small parts. It consists of an arrangement of machine tools and all other operations such as bench work, machining of parts, inspection and assembling, so that each part flows in a continuous even line from the first operation to the second, from the second operation to the third, from the third to the fourth, and so to the last.

3. In the machining room the machine tools, bench work, washing outfits, and inspection are arranged for *each* of the principle difficult parts so that each (by itself) will flow from the first operation to the last in one continuous line; no other part being allowed to enter its particular path.

4. The minor parts are then classified into a few groups (usually not over three) and the machine tools and operations assembled and arranged in accordance with their general type and the sequence ofoperation, a close control being kept over this flow.

5. In the assembling department the *sub-assemblies* will each be assembled by such an arrangement of small operations that the various parts, starting at the first small operation will flow along in a continuous path, the additional parts being added at the various points until at the end there is a complete sub-assembly.

6. Then final assembly will be modeled upon the same plan—

the various sub-assemblies being fed into the final assembly at the proper points, one operation following the other until the product is completed.

7. Of course, this plan is a reversal of the old common plan of grouping together similar machine tools, and also all other operations, whether bench work or assembling, into distinct departments and dragging the parts around the shop from one department to another.

8. In all cases where this "progressive method" has been introduced, the increase in production (using the same operators) has been so very great as to force the conclusion that it is "THE METHOD OF THE FUTURE."

Don't Rip Up the Old Methods too Soon

9. Of course, the writer is not at all in favor of a concern ripping out its old arrangement and going to the new in too hasty a manner.

10. This is a problem that must be studied carefully, although proper plans can be developed in a surprisingly short time if it is done in a systematic manner.

11. This method applies especially to those shops which are producing standard parts in large quantities. The writer has, however, applied it with excellent results to small shops producing a large variety of products.

Select the Main Parts

12. Of course, when I write of arranging machine tools so that parts will flow in a continuous line from one operation to another, I do not mean that this should apply to *every* part for this would be carrying the idea to too great an extreme.

13. I have always divided my problems into two or three classes. First I group together those parts which are the most difficult to manufacture. In other words, "the main parts." Then I apply this "progressive method" of manufacturing to *each* of these, arranging all machine tools and other operations so that each part will flow from one operator to the other in a continuous straight-line flow without any other parts interfering in its path.

Group of Minor Parts

14. Then I group together all the other parts into the second general classification. These are, for example, screw machine or

punch press parts, made in large quantities, and to which the progressive method cannot be applied.

15. It will usually be found that there is a large number of such parts which requires the use of the same machine tools and have only a few short time operations; often the sequence of operation on one will differ entirely from the sequence on another and, as the same machine tools must be used, it therefore becomes impossible to arrange such for my progressive method.

16. A careful study of this general group and a division of it into sub-groups will lead to a rearrangement such as will prove very advantageous. The machine tools and all operations belonging to parts of a similar character are by this plan brought under close control.

Develop Regular Schedules

17. For such parts as are in this second group and subsidiary groups, there must be worked out regular manufacturing schedules. These schedules will cover: 1st, the number of parts to be started upon each shop order (make allowance for scrap); 2nd, the number of shop orders and number of parts that should be in process of manufacture at any one time; 3rd, the number of parts that should be carried in finished parts stores. This will be developed fully later.

Some Examples

18. The first is of a large shop in which the departments were arranged by the old method, namely, all the hand-screw machines were grouped together and all parts requiring hand-screw machine operations, whether it be the first operation or the third or the twentieth, were trucked to this department in turn, and so with the milling machines, the punch presses, the drill presses, even the washing of parts was concentrated in two spots. As a result of this the trucking was a big undertaking. Delays were common and great quantities of materials were tied up all over the shop, thus locking up working capital. The entire shop was rearranged so that for each important part there was a separate and complete line up of machine tools, bench work and room for inspection for the separate production of each. The less important parts were grouped under four distinct divisions.

19. The increases in output resulting from this program reached were very great. These increases were not entirely due to the

progressive methods of arranging the shop but, undoubtedly, it was a very large factor.

20. A prominent firm of engineers made an exhaustive examination of the possibilities of production in the assembling department, studying this out, operation by operation, before this method was adopted.

21. They reported that the maximum output attainable was 15,000 per day in two shifts. We produced with this method and with the same floor space, 38,000 in *one shift.*

22. Another firm after a careful survey, reported 10,000 as the maximum assembly possible and 12,000 as the maximum machining in one shift. The assembling was 38,000 daily in *one* shift and the machining 41,000 per day in two shifts, although on the night shift we worked only a partial force, there being one-half the number of operators that we had on the day shift.

23. In a shop employing 210 men, producing a great variety of work, the machine tools were carefully arranged to take care of the more important parts and thus every part was carefully routed and scheduled. Each part had a day set for starting into work a prescribed number of parts; each lot of parts were scheduled to reach certain operations on certain machine tools at properly set dates. These schedules *had* to be met. No excuses accepted. The situation was further complicated by the necessity of handling special work. However, the regular scheduling of the standard work helped the situation for it showed clearly where the different machines had operated on spare time for the special work.

24. As a result of this work coupled with a fair wage system, the output was increased 235%, using the same machine tools and with a 40% increase in the number of operators.

The Proper Method of Undertaking This Work

25. We must first make a machine tool survey and then a survey of jigs, fixtures, gages, etc., in order to see if we have a proper supply of all to meet the output requirements under this progressive method.

26. Naturally, it will be impossible to so arrange the machine tools as to guarantee the same quantity (allowing for scrap) from each operation. For instance, the machine tools on the first operation on hand screw machines may produce 40,000 per day, while it might prove impossible to group the next operation on the

mills so that their *capacity* will be less than *43,000* daily; this condition being due to the different capacities on different types of machine tools, and to the fact that *ample* capacity (even though it be *over* capacity) must be supplied on each job.

27. Some may say that this represents a loss inasmuch as some of the machine tools are working under capacity. As a matter of fact, this slight inequality amounted to *nothing* compared to the great advantages of saving time, reducing the number of parts in process, and the acquiring of a high degree of skill by the operators working on one type of work continuously. The saving in setting-up time alone (all machines being continuously set up for their one job) far more than overbalances any such slight losses.

28. FIRST STEP. Take *each and every part* and carefully list up *the operations* in their proper sequence.

29. SECOND STEP. List up the *number of parts* that must be produced per hour from each operation, making a careful and liberal *allowance for scrap.* This is important for the scrap will vary on each operation according to the metal, the type of machine tool used, and the tolerances allowed. This is usually *under*-estimated.

30. THIRD STEP. List up the *type of machine tool,* jig, fixture and gage needed for each operation on each part.

31. FOURTH STEP. Calculate with care the *average hourly output* on each operation on every part that may be expected from each machine tool with the necessary jigs or fixtures, using as your basis your "standard hourly output."

32. Be especially careful to examine into the capacity of your gages, for often an output is held back for lack of gages, especially on the parts requiring close inspection. Allowance must be made for wear on gages.

33. The same calculation on "standard hourly output" must be made for operations on bench work so that allowance for bench room may be made.

34. FIFTH STEP. You now calculate from these data the *minimum number of*

(*a*) Machine tools,
(*b*) Jigs or fixtures,
(*c*) Gages,

needed for each operation on every part.

35. Look into carefully the question of jigs and fixtures and make a liberal allowance on those jobs where the jig or fixture may be in the tool room for repairs a goodly part of their time.

36. SIXTH STEP. You then have a complete picture of your product, part by part. You see clearly:

(*a*) The sequence of operations;
(*b*) The number of parts required from each operation;
(*c*) The type of machine tool, jig, fixture, gage needed;
(*d*) The "standard hourly output" that you can expect from each machine tool and operation;
(*e*) FINALLY, THE NUMBER OF MACHINE TOOLS, JIGS AND FIXTURES, GAGES ***needed to produce the required number of parts*** ON EACH OPERATION.

37. SEVENTH STEP. You now list up all of your machine tools, jigs, fixtures, gages, showing types and quantities ***on hand,*** and,

MACHINERY & TOOL SURVEY NAT'L MFG. CO. DATE.....................

PRODUCT.....................................

LIST OF PARTS	NO. OF PARTS MUST BE PRODUCED PER 9 HRS.	TYPE OF MACHINE TOOL	STANDARD HOURLY OUTPUT	NEEDED FOR THIS PRODUCTION			ON HAND IN FACTORY			NET AMOUNT NEEDED		
				MACHINE TOOLS	JIGS OR FIXTURES	GAGES	MACHINE TOOLS	JIGS OR FIXTURES	GAGES	MACHINE TOOLS	JIGS OR FIXTURES	GAGES

FIGURE 43.—Form for Machinery and Tool Survey, Refer to Paragraph 37

knowing ***what you need*** and also ***what you have,*** you at once ***determine whether you have a sufficient number of each to fill your requirements*** or if you have to secure more.

You will usually find surprising over-supplies of some types and *under*-supplies of others.

The form of Figure 43 which is to cover all parts will be found very useful. It gives a permanent record of importance.

38. EIGHTH STEP. Get into the shop your ***needs*** on machine tools, jigs, fixtures, gages and small tools at once. You are then fully equipped.

39. NINTH STEP. You now divide your parts into two groups. The first group comprises those parts which are the most important—which have the greatest number and the most difficult operations.

40. The second group includes the large number of parts of relatively minor importance—which are brought through in large quantities—of which the flow through the shop is not steady and continuous, such as small brass or steel punchings, automatic screw machine parts, etc.

41. TENTH STEP. Take each part of the first group in turn. Starting with the most difficult one, list up the machine tools, the bench space and equipment, the washing outfit, the inspection space needed for the output, operation by operation.

42. Then lay out a portion of the shop selected for this part just as though this were the only part that would be manufactured. See Figure 44.

AN EXAMPLE

43. For instance, on one part *F*-8 I found the following data:

Operations	Daily output requirements	Number of machines, tools or space needed
1st	32,000	28 hand screw machines.
2d	31,000	250 sq. ft. hand tap.
3d	30,500	200 sq. ft. washing outfit.
4th	30,500	220 sq. ft. inspection.
5th	30,000	35 hand screw machines.
6th	29,000	42 thread millers.
7th	28,250	25 hand mills.
8th	27,750	200 sq. ft. washing outfits.
9th	27,000	40 hand screw machines.
10th	26,400	200 sq. ft. washing outfits.
11th	26,400	Inspection.
12th	26,000	Drilling.
13th	25,400	Counterbore.
14th	25,000	Final inspection.
15th	25,000	To finished parts stores.

44. For each type of machine tool we figured the total amount of space needed for machines—operators—parts and stock movements. From this we worked out the layout.

45. It is important to note that on the part *F*-9 the part was light and the machining for the most part was small. Therefore, the operations were arranged so that the parts could be passed directly down the bench to the next operation. See Figure 45.

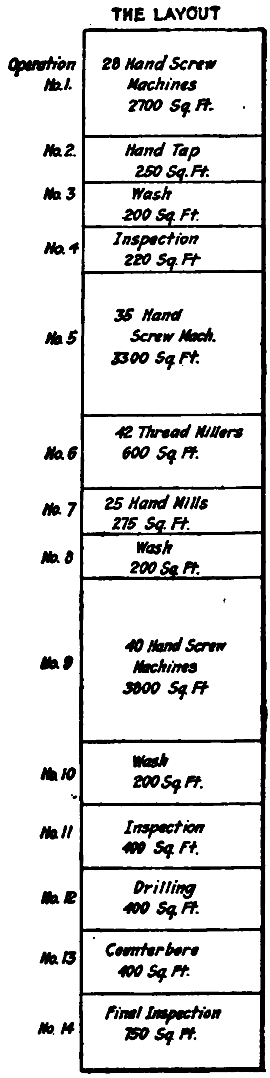


FIGURE 44. Diagram Layout of a Portion of a Machine Shop, Refer to Paragraph 44

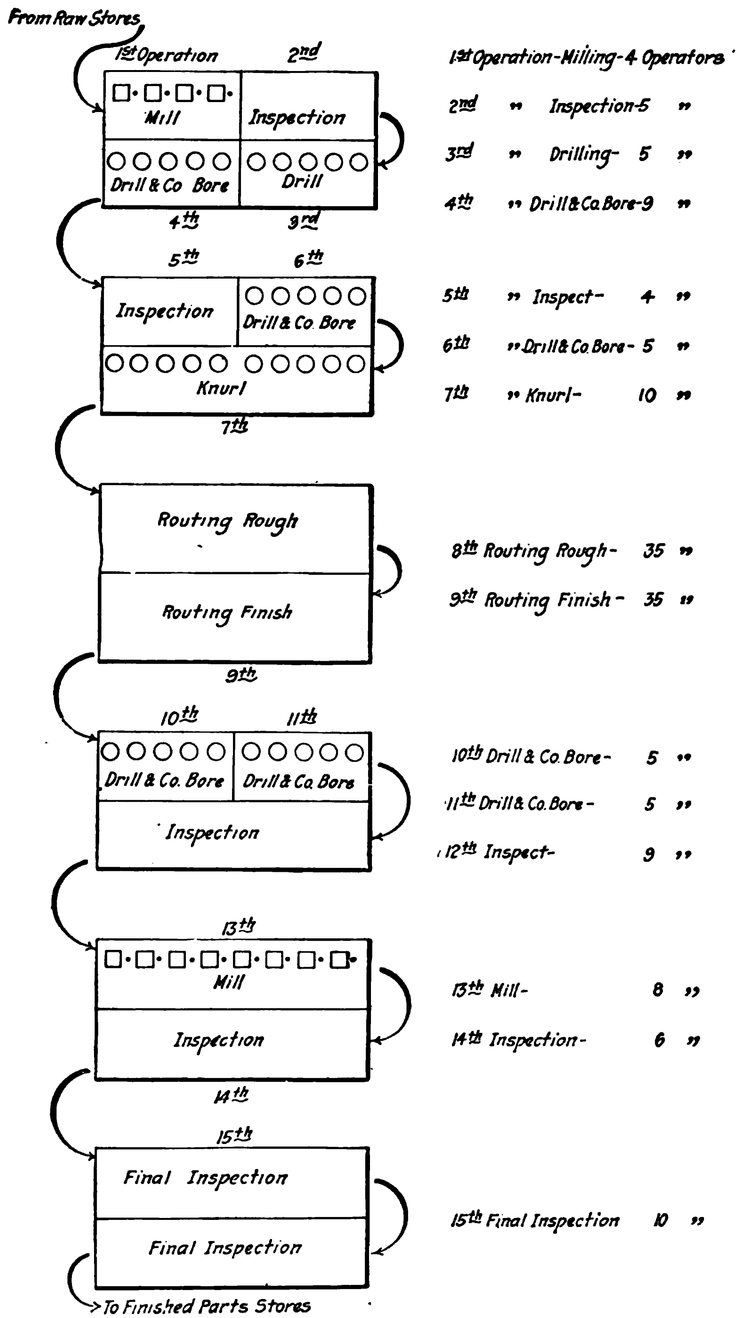


FIGURE 45.—Arrangement of Operations on a Typical Part, Refer to Paragraph 48

46. On the part *F*-10 the same condition prevailed. the layout being of the same character.

On part *H*-8, *H*-10, *H*-16, *F*-6, *F*-9 we used the first method of layout shown on page 291.

On parts *F*-10, *F*-11, *F*-13, *F*-20, *F*-32 we used the second method of layout shown on page 292.

47. These two parts will demonstrate the principle. On one product involving 164 separate parts it was found practicable to use this progressive method of machining on 24 of them.

48. The balance were minor parts. We divided these into three groups, placing parts requiring similar operations and similar machine tools in the same group.

The Advantage

49. The moment this plan is effective a great change will come over the shop. Instead of there being separate departments for each type of machine tools, there are separate departments for *each part* or group of parts.

50. A foreman will have charge of the full production of one part or one group involving the use of a number of different machine tools. He is, therefore, responsible for the complete product of that one part. There is no longer any room for excuses. He can no longer lay the blame on some other foreman. It is his duty to keep his entire line-up busy every moment.

Flow of Parts Perfect

51. The flow of parts *must be perfect.* It is all arranged like a train of gears. They *must all operate together.* There is usually no room allowed for an accumuation of parts. The instant any one of the operations lessens its standard output, just that moment does the stock begin to pile up back of it and the department ahead of it begins to run out of parts. A roar will soon arise from each of these sub-foremen in charge of the departments before and after the one causing the trouble. Under some conditions an allowance may be made for a small accumulation of parts between some operations but generally better results will result from the plan outlined.

No Excuses Allowed

52. No sub-foreman can possibly hide any failure. It shows up *at once.* You may be sure that each man is up on his toes for *no excuses* can be accepted for a shut-down, no matter *what* the cause. It should have been foreseen and provision made for it.

53. Were some jigs sent to the tool room held too long for repairs? No excuse. The sub-foreman should have traced them up. Did some of the machine tools fail? Their condition should have been reported so that they could have been repaired at night if necessary. *Everything must be foreseen.*

Reduction of Parts in Process

54. It is evident that this plan will reduce to a minimum the number of parts in process of manufacture and consequently, the working capital involved. Some remarkable reductions have been accomplished by this method. In one shop producing 20,000 articles daily the average time required for parts to get through the shop—lying around in the departments as they did—was 20 days. This meant 400,000 sets of parts tied up in process of an average value of $1.10 each, or $440,000. The introduction of this method resulted in a reduction of this average tie up to *one week of* 5½ days which required only 110,000 parts in process or a tie up of $121,100 in working capital. The saving of interest for one year on the $319,000 released more than paid for this change. The amount of stores in finished parts stores was also largely reduced as there was now an unfailing supply of parts. Three days' supply instead of eight was sufficient.

No Delays in Assembling Room

55. Delays in the assembling room disappeared. The flow was even and steady. This also brought a large increase in output.

Stock Tracing

56. The tracing of parts was very simple. One man did the work that formerly required five. In fact, stock tracing was well nigh unnecessary except on those parts which were included in the four groups.

57. There is probably nothing in all production methods that will so increase the output, release tied up working capital and relieve the entire force of superintendents and foremen from worry as this will. It also has the effect of stabilizing costs.

Eliminates Systems Needed

58. It will eliminate the need for system and its attendant expense to a large degree. There would be no great need for a mass

of production reports; costs are greatly simplified; stock tracing amounts to little and each machine is *forced* to operate up to its standard output.

59. By this plan you have all the operations on each part so geared up in sequence that your organization *has* to

1. Produce their scheduled quantities;
2. Start a certain number of parts into process each day on a regular program that stores and purchasing department *must* meet.
3. Finish a certain number of parts each day which the assembling room *must* assemble.
4. Keep up the standard hourly output with the prescribed number of operations.
5. Keep within the specified costs.

The Assembling Department

60. Progressive assembly possesses equally as great possibilities. It is usually easier to apply this progressive method to assembling than to machining.

The Results

61. The results when this method is applied to assembling are even better than when adapted to machining because the method adapts itself particularly to any production in which the jobs can be analyzed into their finest smallest elements.

The Usual Method

62. Usually assembling is done by dividing the work into certain sub-assemblies, each of which, however, represents a large number of different operations performed by each operator.

My Method

63. My method is to reverse this and regroup the operations. The part will start with operation number one, performed by operator number one, will then go to operator number two for operation number two, and so on until the last operator finally finishes the part.

An Example

64. On the assembly of *H*-8, I had 104 operators. They were

when under the old plan, divided into four (4) sub-assemblies. The first group finished five operations—the second group finished six operations—the third group finished 11 operations, and the fourth group completed four operations. The average output was 1300 per hour.

65. I changed this by forming four groups of 26 operators each. A long wide bench was arranged and operators and inspectors were seated along both sides. The operations were arranged one following the other; the machine tools such as small hand mills and drill presses were placed at their proper locations. See Figure 46.

66. The sequence of operations now becomes as follows:

1. Inspection	1 operation	11. Place screw........	1 operation
2. Mill face...........	1 operation	12. Run-in screw......	1 operation
3. Mill back..........	2 operations	13. Inspection	1 operation
4. Inspection	1 operation	14. Apply glue.........	1 operation
5. Drill (*a*)	1 operation	15. Put on felt.........	2 operations
6. Drill (*b*)	2 operations	16. Press felt..........	1 operation
7. Put-in powder	2 operations	17. Assemble in *H*-46..	3 operations
8. Press powder......	1 operation	18. Stake *H*-46.........	1 operation
9. Apply glue.........	1 operation	19. Final Inspection....	1 operation
10. Apply gauze........	2 operations		

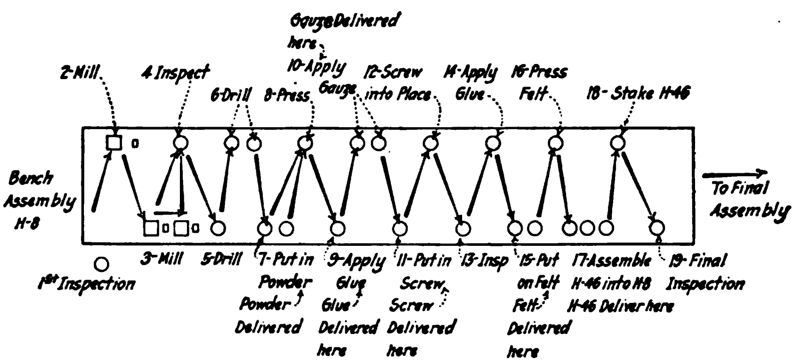


FIGURE 46.—Rearrangement of Bench and Holders for a Typical Assembly Operation, Refer to Paragraph 65

67. Fast operators were placed at the first operation, a few fast ones at the last operation and several at intervening operations.

THE GROUP BONUS

68. The operators were paid by the group bonus plan described

on pages 404 to 408. In brief, this included first a day rate to each operator, the amount of which depended upon the skill required for the job. The operators were paid a substantial bonus which depended upon the final output of the entire group. This bonus was divided up amongst the operators in accordance with their day rate and the time spent on the job. (Skilled floating operators were provided to take the place of any absent regulars.)

69. It is thus evident that the good operators will press for a big output and carry the poor ones up with them. We provided special instructors to help out and train the new or poor workers, this being necessary as the work was exacting. The skilled operators would also help the slower ones along.

70. This all resulted in a large increase in output. The average output was raised from 1300 per hour to 3100 per hour with the same number of operators.

71. Note that the small machine tools and inspectors, etc., are placed in line. The part began at the left end. As it traveled from one operator to another it received various other additional parts such as gauze, felt, powder, which were fed into the table at the proper points. When the part reached the end of the table, it was completed.

72. The various other parts were handled in the same way. When each part was thus completed they were all brought together on the final assembly which was arranged in the same manner. As the part traveled down the line from one operator to another, the different component parts were fed into it and added to the parts already assembled. When the product reached the end of this bench, it was complete, ready for packing.

73. It is evident that such a method has everything in its favor. Each operator becomes highly skilled on his job—the speed of production is kept up to a high pitch by the operators themselves. The work is better done because each operator enters his attention only on one small thing he has to do.

How to Plan this Method

74. In order to plan this method for the assembling department, follow the same plans as in the case of the machining. First, consider the assemblage *as a whole*, forgetting the old sub-assemblies, and then divide it into its *smallest operations*. Whatever separate movement or operation is performed, no matter how small, be sure to put it down.

75. For instance, take the case of considering an operation of "gluing on parchment paper on part *H*-3." List this up as (1) receiving part and applying glue; (2) placing parchment paper on glue; (3) pressing parchment firmly into place on glue; (4) inspecting to see that paper is properly placed and firmly glued. *Pressing powder in brass cup* will be divided into (1) measuring proper amount of powder; (2) picking up cup and examining it to see if clean and free from moisture; (3) pouring powder into cup; (4) pressing powder into cup; (5) inspection. This *must be done* in order that you may determine what operations shall be done singly—and what ones combined to facilitate production.

Method of Conveying Parts from One Operator to Another

76. I find sometimes a tendency for a man to be too one-sided on this question. There is no one method that will suit all shops—there is usually no one method that will fit *all* the conditions in any one shop.

77. Traveling belts are usually the first choice. They are excellent when the work need not be carefully done. I have found, however, that in cases where great accuracy and mental concentration is necessary, their use tends to make the operator nervous and may cause a slighting of the work. In such cases I have used troughs arranged so that the work may be slid along from one operator to another. Other means of conveying work have been devised. My one caution, however, is to use any system wisely, and do not allow it to crowd the operator to the point of too great nervous tension.

The Final Result

78. These methods can only be barely outlined in a short chapter. The influence of my progressive method of manufacturing reaches with its efficiency and economies to every department in a shop. The entire control is tied up so that nothing can go wrong. The biggest production, the lowest costs, are *forced* out of the shop. The results of introducing these methods in American factories have in every case been astounding in their increased production and cut in costs.

CHAPTER XIV

THE PURCHASING DEPARTMENT

This Department Can Either Make or Break YOU

1. THE three *vital* points that any manufacturer, large or small, has *got* to consider: 1st. Buying; 2d. Labor; 3d. Overhead. Carelessness in any one of these branches will surely eat up his profits.

2. Mr. Small Manufacturer knows well enough that he has to *buy right*—to keep his material cost within his estimate or he will surely lose out. How much *more* important it is for the big fellows to buy *right* when there are such a horde of chances for something to go wrong. Material or tools purchased at too high a price, defective material brought into the shop, overbuying, thus eating up the company's working capital, underbuying, thus causing delay after delay in the shop with untold losses.

TYING UP OF WORKING CAPITAL

3. Most men think of the purchasing department only as the one that buys materials at the proper price. It does not seem to occur to them that the purchasing department coupled up with the stores can do more to uselessly absorb more of their much needed working capital than all other departments combined. The amount of working capital that can be permanently absorbed by the stores and purchasing department overbuying—loading up the factory with useless and dead material—is nothing short of astounding.

4. In a small company whose entire working capital was less than $200,000, I found over $55,000 that could be released by a simple system properly carried out. In another case we found over $325,000 tied up. In every case, without exception, large sums were involved. The companies' relief over getting this money into the bank instead of having it tied up in useless material was very great indeed.

OVERBUYING—UNDERBUYING—ACCUMULATIONS—SHORTAGES MUST BE STOPPED

5. These methods will be developed so that overbuying, under-

buying, accumulations of dead materials, delays on account of material shortage, receiving of defective materials, will be practically impossible.

6. They will provide a sensible system combined with a get-together method bringing together once every two weeks the general manager, superintendent, purchasing agent, stores keeper and stock tracer; will give the management a close touch; a real *control* of the purchasing department; let them know what is going on; allow them to help the purchasing agent.

7. One big trouble with this situation usually is that the purchasing agent is selected and the department *dumped* on him. The stores department—which *should* co-operate—is usually busy covering up its multitude of mistakes and delays in placing orders by blaming the purchasing department; the superintendent, who probably failed to supply proper complete specifications in the first place, gets busy blaming the purchasing agent because materials are not right; the front office probably holding up big requisitions too long.

8. In short, the average purchasing agent has to labor under the great disadvantage of rushing in materials that stores should have ordered weeks before or which were held up because some official kept the requisition on his desk too long. Getting in materials under incomplete specifications and *he* getting the blame for imperfect materials. Everybody "blames it on the purchasing agent." He lets out a wail or two at first, hoping to correct these troubles, but he soon finds it useless and "lets it go at that."

9. Now it's all very wrong to let such conditions exist. No man can buy to the best advantage when working under conditions where it's *impossible* for him to get the proper quotation. Wander into your own purchasing department; sit down for a pleasant smoke; sympathize a bit with your head man, then get him to tell you how many items he had to rush in by express the past 60 days. His reply will startle you. Then start to dig for the reasons.

10. Any man, not a fool, can figure out for himself what *he* should have in order to buy right. Well, then! Give such methods to your purchasing agent. There's no red tape about what I am going to propose. Every single form is necessary, for remember! Your purchasing agent has too many items to handle to make it safe to do any "remembering" or "guessing."

11. Let's consider the fact that he is responsible for a very big expenditure and that he must have some real system to keep track of the details.

WHAT THE PURCHASING AGENT'S METHODS MUST COVER

Material List

12. First. He must have a complete and accurate list of all the material requirements for *each* product showing quantities required.

Combined Material List

13. Second. He must combine all of these so that he will have an accurate list of all materials needed for *all* products.

Specifications

14. Third. He must have full and complete specifications on each and every class of material on which to purchase.

Market Survey

15. Fourth. He must make a market survey to determine *all* the sources of material supplies and provide methods for watching the markets, both domestic and foreign, for any big movements either up or down.

Quotation Records

16. Fifth. He must get proper quotations and keep these on quotation cards (keeping them revised) so that he can determine the best concerns to buy from, considering price, quality, service.

Order Records

17. Sixth. He must keep his orders listed up on "order cards" so that he can locate all unfilled orders at once—such cards showing promised dates of delivery and the necessity for rushing materials.

Follow Up

18. Seventh. He must keep a "follow-up" system that will keep him and the management in close touch with all orders that may be in serious condition, and that will force his department to keep after the delinquent manufacturers.

Filing System

19. Eighth. He must have a good filing system so that at all times he can put his hands on a complete history of any order.

Checking Prices

20. Ninth. He must have a good system of checking prices on bills on goods received. Check against quotation records and prices.

Pushing Improvements

21. Tenth. He must have a good method of getting in touch with all new materials and tools appearing on the market and an efficient system of getting shop reports on these so that the company may get the benefit of the improvements appearing so often.

Co-operate with Stores

22. Eleventh. He must work in closest conjunction with the stores department and the stock tracing department in order to anticipate wants, rush in much needed materials, avoid overbuying and the accumulation of dead materials.

Sales Department Co-operation

23. Twelfth. He must watch the trend of sales and ascertain from the sales manager at least once a month what lines will be pushed and what will not be concentrated upon. This will provide an excellent guide for purchasing of all materials.

Reports to General Manager

24. Thirteenth. He must keep in close touch with the general manager by special reports and committee meetings so that he may keep him advised constantly of buying conditions and may get his help and that of the other officials in the closing of important contracts.

25. Any good business man will say that all of these points should be covered by a good purchasing department. I will illustrate each point with forms which have been used with success in many different lines.

26. In some businesses these forms will have to be altered, but the general idea should be maintained. The methods and records to be developed are:

1. The material survey by products;
2. The material survey—all products combined;
3. The specifications;
4. The market survey;
5. The quotation records;
6. The order records;
7. The follow-up;
8. Improvement data; and
9. Reports.

27. (1) The material survey by products. (*a*) Each product must be considered by itself. The parts must be listed up by the engineering department one under the other (it is best to group all parts of similar material together), clearly showing the quantity of materials (allowing for scrap) required for 1000 complete

MATERIAL SURVEY (BY PRODUCTS) DATE..............

NATIONAL MANUFACTURING CO.

PRODUCT.. YEARLY PRODUCTION ....

IF SALES AND PRODUCTION ARE SEASONABLE, REPORT PRODUCTION FOR PERIODS OF

MAR, APR, MAY................ JUNE, JULY, AUG............. SEPT, OCT, NOV,......... DEC, JAN, FEB,.......

MATERIAL	NAME OR SYMBOL OF PART	CONDENSED SPECIFICATION		AMOUNT NEEDED FOR YEARLY PRODUCTION	AMOUNT NEEDED PER 1000 ARTICLES	NOTES
		DESCRIPTION	SPEC. NO.			

FIGURE 47.—Form for Material Survey, Refer to Paragraph 27

products, and also for the yearly production required. This is done to facilitate future calculations. (*b*) Then the amounts required for six months' run. This is to be checked every 30 days against the sales department's records. See Figure 47.

28. (2) *The Totalized Material Survey.* After such a list as shown above is made out for *each product* then these are all to be combined in one *grand totalled report.*

29. Thus you at once have a complete list of the company's requirements on materials for all products—this being built up on

the material survey for *each* product. The moment the sales department determines on a policy that will increase or decrease the demand for any one product just this moment must they notify the purchasing department.

30. This department will then revise their material survey for the product affected and thus make a corresponding change on the totalized materials survey.

31. It is important to note that all materials usually classed

MATERIAL SURVEY **NAT'L M'F'G CO.** DATE............
ALL PRODUCTS
WHAT PRODUCTS YEARLY PRODUCTION
(a)........................ (a)........................
(b)........................ (b)........................
(c)........................ (c)........................
(d)........................ (d)........................
IF PRODUCTION IS SEASONABLE, EXPLAIN..................

MATERIAL	NAME OR SYMBOL OF PARTS	CONDENSED SPECIFICATION		AMOUNT NEEDED FOR YEARLY PRODUCTION	NOTES
		DESCRIPTION	SPEC. NO.		

FIGURE 48.—Form for Material Survey of all Products, Refer to Paragraph 35

under overhead or indirect materials, such as shellac, ink, oils, grease, lacquer, drills, taps, etc., should be listed up also.

32. A similar list of general supplies should also be made up.

33. Thus the purchasing department and the management will have at all times a *complete list* of all materials required in the business showing character, quality, quantities, all right "up to the minute." See Figure 48.

34. (3) THE SPECIFICATIONS. The course that many concerns take on "specifications" is nothing short of stupid. How they can expect to get in their materials correctly when the purchasing de-

partment has incorrect or incomplete specifications is beyond understanding. Yet, it is the exception when the purchasing department is supplied with proper specifications on all materials.

35. One large concern doing a business of many millions was lately thrown into a panic because they found that over 180,000 forgings had gotten into the shop and were well on their way to the stock room before it was discovered that the analysis was entirely incorrect and they could not be used. It was found that the purchasing department's specifications were not complete. As it required two weeks to get new forgings it cost this company over $40,000 (in lost time, overhead and paid wages) to learn the costliness of incomplete specifications. Just another lesson proving that big troubles come from little ones.

36. Your purchasing department *must have full complete specifications* on every kind of material purchased. The parts must be divided into two classes: One requiring special specifications covering (*a*) analysis, (*b*) physical characteristics, (*c*) working qualities, (*d*) any unusual requirements, (*e*) size, etc., (*f*) how much used in six months, (*g*) how much to order at one time, (*h*) revision every 60 days. The other class covering materials classed under "commercial stock."

37. It is often difficult to get such specifications from the organization—but it *must* be done. Call together your technical men, your superintendents of production and inspection, your head of stores and your purchasing agent, and insist that a specification be made out for every class of material. Stick to it until it is *done*.

System of Testing

38. At the time the specifications are prepared be sure to get up complete methods of testing materials so as to be able to ascertain if materials are up to requirements. Then deputize certain of your men to make these tests under the supervision of the inspection department. Much assistance can be given by colleges if near at hand, for they ordinarily have the equipment that the manufacturer ordinarily does not have.

39. If the manufacturer has some difficult problems in setting standards he can get his problem solved by conferring with some of the technical schools, bureaus or associations such as the universities, Government Bureaus of Standards, Washington, D. C.; National Fire Protection Association, Underwriters' Laboratories, American Chemical Society, American Society of Refrigerating

Engineers, American Society of Mechanical Engineers, American Society of Electrical Engineers, American Steel Manufacturers Association, National Paint Manufacturers Association, etc.

40. Frequently, however, your superintendent and foremen can devise simple, practical, factory tests that will serve all purposes. This question will be covered more fully in the chapter on Inspection.

Caution! Do Not Go Too Far

41. While full specifications are necessary to insure successful manufacturing still be careful not to insist upon specifications unnecessarily rigid for you will thus limit your market, make your trade unattractive, and bring upon you high prices.

42. Whatever you buy—be it steel, bronze, aluminum, machine tools, boilers, generators, motors or anything else—be careful to adhere to the manufacturing standards wherever you possibly can. If you ***must*** specify restrictions then request the manufacturer to send in at the same time a bid upon his standards with complete explanations. You will often find that you can substitute some standard for your special articles. Never do this, however, until you have gotten full approval from the factory management.

Blue Prints

43. When sending out blue prints with the specifications be very careful to see that they are the very latest. A good plan is for the purchasing agent to get the superintendent's or engineer's O. K. on blue prints before sending them out, retaining an O. K.'d one in his files. In your inquiries and orders be very careful to state specifically the number and symbol of the blue print to be followed. Copies of these specifications should be sent to the works manager, chief engineer, superintendent of production, superintendent of inspection, stores, purchasing department, general manager.

41. They should be gone over completely every two months for revisions.

No Changes Allowed

42. Absolutely *no change* in any specification, in the smallest particular, can be allowed unless approved by the works manager and the chief engineer together.

43. I find it very useful to put all specifications for materials for each product upon blue-print sheets in cases where the specifica-

tions are not too lengthy, grouping similar materials into classes.

44. (4) THE MARKET SURVEY. Having the exact quantities of

MARKET SURVEY. NAT'L MFG. CO. DATE ....

MATERIAL ....

SPECIFICATION (CONDENSED) ....

....

.... AMOUNT USED YEARLY ....

MANUFACTURERS				
CHARACTER OF PRODUCT				
LOCATION				
ON WHAT R.R.				
SIZE FACTORY				
NUMBER EMPLOYEES				
WHAT OTHER PRODUCTS MADE.				
CREDIT RATING				
REPUTATION FOR QUALITY				
" " SERVICE				
OTHER IMPORTANT CUSTOMERS.				
NAME OF PRESIDENT				
" " GEN'L MGR.				
" " PUR. AGENT.				
" " FACTORY MGR.				
WHOM DO YOU RECOMMEND?				

FIGURE 49.—Form for Market Survey, Refer to Paragraph 49

material required, and then the specifications giving quality required, the next logical step is to "LOCATE THE POSSIBLE MARKETS" in which the materials can be bought. This is usually done in a hit or miss

style. When the purchasing agent or the superintendent happens to know a few concerns that handle different lines; they often go ahead dealing with these concerns, overlooking many a source of supply that could give better service and lower prices. See Figure 49.

45. A first-class survey of the market conditions will reveal many surprising things. Often you will find some plants near at hand that can supply you with a superior article.

Splitting Up Your Buying

46. Buying exclusively from one concern is usually bad policy. Friendly relations with your sellers is a good thing, but it can be carried too far. Keep on good terms with them, but also "keep them on their toes" on deliveries, prices and quality by having at least two sources of supply. This plan is also a better way to insure deliveries.

How to Get the List

47. A satisfactory list can be made up by referring to Buyers' Guides, Dun's and Bradstreet's lists, trade journals, newspapers, government reports, list of members of trade associations, technical journals, visiting salesmen, chambers of commerce especially in manufacturing centers, machinery manufacturers, jobbers and dealers.

48. Such a list is invaluable and needs careful study. It should be revised every two months.

49. Thus you know where to look to for your supplies in full confidence that you can select your best sources of supplies, and you are now in a position to get your quotation.

Getting Quotations—How to Proceed

50. As stated previously, you must have a complete and safe specification on all methods before you start.

Possible Substitution of Standards

51. It is usually well, however, not to insist upon the specification too rigidly on your first inquiry unless it is a very essential requirement, for the manufacturers may decline to bid at all—the American manufacturer disliking to vary from his standards. It is well to send in the specification, asking the manufacturer to bid upon it and also to bid upon his standard nearest to this requirement, requesting a full description of the differences and the advantages of his product.

52. I have found in many cases that after laying the manufacturer's data on his standard before the committee (chief engineer, head of production, inspection, stores and purchasing), it was possible to substitute the standard for the material originally specified to the very great advantage to the company in costs.

Handling of Quotations

53. As soon as quotations are received they must be entered upon the "quotation record" shown below. All unanswered requests for quotations should be held in a pending file and followed up.

65. Revise the quotation records every ninety days or oftener.

The Danger Signal

54. The "estimated cost" provides an excellent *danger signal.* As soon as the purchasing agent finds that he *cannot* buy within

NAME OF 10 MOST IMPORTANT PURCHASES	YEARLY PURCHASES				FROM WHOM BOUGHT	LOCATION	QUOTATIONS GIVE NAMES & QUOTATIONS OF 3 COMPETITORS						EXPLANATIONS
	THIS YEAR		LAST YEAR										
	AMOUNT	PRICE	AMOUNT	PRICE			NAME	PRICE	NAME	PRICE	NAME	PRICE	

FIGURE 49-A.—Form to be Used in Making Survey of Purchase Quotations

the estimated mean cost he must *immediately* notify the general manager, the sales manager, the cost department. At once they can determine if such conditions can be overcome or if they will require an increase in sales prices. Nothing is so maddening to the general manager as the discovery through the *cost returns* that costs have jumped up owing to higher prices for materials *after* purchases have been made, materials in the shop, and many sales made at the old prices.

55. The column "market quotations" is an important one. This should be kept up, the data being secured from (*a*) newspapers, (*b*) trade journals, etc.

56 This "quotation record" *must be* kept up. Nothing is easier than for the purchasing agent to establish some steady connections

on the important lines and then never change nor endeavor to get competitor's quotations. However, this is not "buying right." It is only a method of "placing orders," and any simpleton can do that.

57. The "quotation records" must be revised every 60 days. They should be placed before the general manager every two weeks for his observations and instructions.

The Placing of Orders

58. At this point the purchasing department is ready to place orders as soon as proper instructions and requisitions come through.

The Requisition

59. The handling of this requisition is an important one for it is the key note of the whole situation. The requisition determines how ***much*** shall be bought of any article and ***when***. As tens of thousands of dollars are involved, it is nothing to pass over lightly.

60. The usual method of handling the requisitions is thoroughly foolish. The purchasing department usually waits for the stores keeper to issue it. The stores keeper is often far from knowing much about accounting and the necessity of keeping his accounts absolutely correct.

Factory Bank

61. The company officials seldom seem to realize that their stores keeper is running a factory bank with an amount in materials often far larger than the bank account itself. He is often selected because he happens to know the parts, but instead of being as keen as a razor in keeping his card records straight he is usually careless about both requisitions and his records, not "seeing the sense of all that red tape."

Stores Department Often a "Mess"

62. His bin stock cards, showing receipts and deliveries, are carelessly kept, while he issues his requisitions upon order limits originally "made up" "heavens only knows" how. It's always a safe wager that stores, with its incorrect order limits and carelessly kept receipts and deliveries, is inefficient. This condition will be dealt with in the chapter on "stores." Now, from this unstable inefficient source issues forth the "requisition."

Results

63. The results are (*a*) requisitions coming to purchasing department so late that material runs out before new material can be rushed in; (*b*) requisitions coming into purchasing department for materials in which there is already an over-supply; (*c*) requisitions coming into purchasing department steadily for materials on products on which the sale has been abandoned and, as results, delay after delay and loading up of unused material.

Purchasing Department and Stores Must Be Made to Co-operate

64. Perhaps somewheres on this earth these two departments are really co-operating, and thus really trying to save the company money, but we haven't struck it yet. They usually get along as nicely together as two strange bulldogs. Each one seems to wait to catch the other in some delinquency.

65. Now, they must be *made* to co-operate. They must be *jointly* held responsible for delays that cost so much—for the sinking of valuable dollars into useless material.

Keep Their Records Together

66. Their records must be so kept together that what one does not catch the other is sure to.

Delays in Getting Requisitions Through

67. Next in order of inefficiency is the delay encountered in getting requisitions from the stores through official after official for O. K.'s and finally to the purchasing department. The requisition often arrives in the purchasing department about the time that the *material ought* to be coming through the receiving department's gate. Each officer in turn, annoyed at the idea of O. K.'ing a lot of requisitions that he doesn't know anything about, cheerfully lets them lie on his desk until he has a good-sized pile of them. After about four men have done this same thing "there's hob to pay" and trouble ahead for the purchasing agent.

The Way to "Turn the Trick"

68. There is one way to overcome these troubles that I have always found to be simplicity itself, and while it is described fully in the chapter on Stores, briefly, it is as follows:

The Big Requisition

69. 1st. Arrange a method whereby one *big requisition* for *all standard materials required for four months or for any special job* shall be O. K.'d once and for all by the officials, and then provide a check against overbuying, through the work of the treasurer's department.

70. Take each product, whether standard or special, and make up a complete list of material requirements through the engineering department for this period of four months. Let this contain all quantities and prices. Pass this big requisition on to the company's officials who can then see what and how much is involved. When they once approve this it is the last that any of them are bothered with requisitions requiring approval.

They are passed back to stores and purchasing, the treasurer keeping one copy. Then all following requisitions and purchase orders referring to this work are sent to the treasurer who checks these against the approved big requisition before approving them. This provides a perfect check against overbuying—saves much time. The purchasing department can buy better because of the larger quantities involved and the treasurer has an idea of the obligations he must meet on accounts payable for several months ahead.

71. The full description of the use of this blanket requisition is given in Chapter XV, describing Stores.

The Committee

72. The treasurer (and possibly the general manager) should have a committee meeting every week with purchasing agent, stores, costs, stock tracer to go over carefully all items of stock needing attention. At this meeting they should consider with care all items of stock that are badly needed, digging into the subject until they find out the reasons and then taking prompt actions—also those items which are over-bought and those which are dead.

73. The amount of parts in the assembly room, finished parts stores, and work in process should also be considered. Here's where the stock tracer and stores man with their records play an important part.

74. This committee must make an effort to balance up parts and raw materials properly, making due allowance for the difference in manufacturing conditions. Every last dollar of dead working capital should be squeezed out. The treasurer will find this a rich field.

75. Having gotten our material requirements, our market survey, our quotations, our requisitions and purchasing orders, we now come to the listing up of orders on the "order record." See Figure 50.

76. This form is self-explanatory. Each material will have its one "order record," and this will show the complete record of *all* orders for each material.

77. Column 7—Promised Delivery Date—must be kept up faithfully, for the dates are the foundation for the "follow up" which should stop delays.

78. These "order records" should be the "hobby" of the purchasing agent. The head man should study them at every spare moment, making searching inquiries of the "follow up man" to see if any item is in a dangerous condition—ready himself to "get on the job."

PURCHASE ORDER RECORD

NATIONAL MANUFACTURING CO.

MATERIAL-KIND .... DESCRIPTION ....

USED ON (GIVE QUANTITY) ....

.... TOTAL MONTHLY CONSUMPTION ....

AMOUNT TO ORDER AT ONE TIME ....

AVERAGE TIME TO GET IN MATERIALS .... ORDER LIMIT .... RUSH LIMIT ....

DATE	PURCHASE ORDER NO.	DATE OF APPROVAL	STORES REQ. NO.	QUANTITY ORDERED	FROM	PROMISED DELIVERY DATE	NO. DAYS SUPPLY IN STORES WHEN ORDER IS PLACED	DELIVERIES						
								DATE	AMT.	DATE	AMT.	DATE	AMT.	

FIGURE 50.—Form for Purchase Order Record, Refer to Paragraph 75

79. It's the business of the purchasing agent to not only *buy the right* material at the *right prices,* but also to *"get it into that shop."*

80. He must report all items requiring "rushing" to the general manager and also to the committee, explaining why they *have* to be rushed. A "stitch in time" surely applies to the purchasing agent in these matters.

81. The one big principle to hold the purchasing agent and stores department to is: "Delays will *not* be tolerated and excuses will *not* be allowed—get the stuff into this shop on time."

THE FOLLOW UP

82. An alert, wide-awake man must be put in charge of the follow up. He must watch the promised dates of shipments shown

on the "order records" like a hawk and begin to write the manufacturers letters of inquiry several weeks at least before the date promised.

83. He will handle all rush items reported from the stores department in the same manner.

84. He will use a "follow up" form similar to Figure 51.

85. All such items should be taken up by the follow-up man with the head purchasing agent at least once a week—any dangerous item should be considered with him immediately.

86. He should make out a special report to the department head every 30 days covering his work, showing what items were late in shipment and why.

FOLLOW UP NAT'L MFG. CO. DATE..............

URGENT!

ON ...(Date).... THE FOLLOWING MATERIALS MUST BE IN THIS SHOP.

MATERIAL................PURCHASE ORDER NO......PLACED WITH........

AMOUNT..............PROMISED DELIVERY DATE....................

AMOUNT IN STORES ON.......IS..............; WILL LAST......DAYS

DATES FOR FOLLOW-UP	ACTUAL FOLLOW-UP		REPORTS FROM MANUFACTURER	Notations
	DATE	HOW		

FIGURE 51.—Form for Follow-Up of Materials, Refer to Paragraph 84

87. This "follow-up" is one of those jobs that do not appear very important as long as it is being run efficiently but when it is not being attended to properly, it will surely "make a mess of affairs." No matter how well the stores and buying may be managed, this little "follow up" system when neglected will surely upset all calculations for then the proper shipment of materials will surely be neglected.

Handling New Discoveries

88. New alloys, new products, effective substitutes for old materials, new processes and methods of all kinds are continually ap-

pearing on the market, many of which possess great possibilities toward economies. The purchasing department is the one that comes into contact with all such new conditions either through the advertisements and circulars or through the visiting salesmen.

89. In the old days when I did the buying for my own concern I learned of some of the best paying improvements that I ever installed through traveling salesemen who became interested and wanted to help. I found that many a valuable method used by companies on entirely different work could be adapted to mine with great profit.

Difficulty in Getting Reports from the Shop

90. Every purchasing agent that ever lived has an almost hopeless time in getting reports from the superintendent and foremen on materials, tools, etc., that are sent by him into the shop for tests. Shop men are very conservative. If they have something that they are satisfied with they hate to change. They get their new samples, and either forget them or send them into the shop carelessly where they are lost or neglected. They often seem to resent such actions by the purchasing agent, as though it were unwarranted interference with their authority. Such an attitude is foolish, but must be reckoned with.

How to Get Their Co-operation

91. The shop men must first *be* impressed with the fact that the *management* regards the man who will not make such investigations as a "dead one" and will *insist* on investigations and proper reports being made.

The following form may be used:

The National Manufacturing Company

It is important for this shop to test out every promising material, tool, etc., that is submitted. Therefore, everyone getting this blank with article to be tested, is expected to test it out carefully and report. A copy of this has been sent to the general manager's office—the purchasing department will report on this to the general manager.

Mr. J. Brown,
General Manager.

Mr. .... Date..............

The following articles have been sent us for test by............

....

Description	Character of Work	Claims of the Mfgr.

....

Signed........................

Please return with report by..................

FIGURE 51-A.—Form Asking for Investigation

92. One copy is sent to the superintendent for his guidance, another to the general manager who should check them up for reports once a month, and the third retained by the purchasing department in order to follow up.

93. This method *forces* results—makes the superintendent and foremen get back of these reports—because the *general manager's* office is also watching these reports and is liable to pounce upon a delinquent.

No Small Matter

94. This is no small matter. (Though it is usually sadly neglected.) Common sense tells a man that every day there are appearing improvements in methods, tools, and materials that will aid in reducing costs. If neglected, the company will miss many a chance to cut down costs; and some competitor will ***not.***

The Filing System

95. The best system is one that keeps together all data relating to each separate order. Do not, under any conditions, scatter the data. When a question comes up about any order, filled or unfilled, and you want the data, you ought to get it in one bunch together.

96. Therefore, the best system is filing by subject with a cross index to order number and one to names. Of course, you can file under order number with a cross index to subject and also to names.

97. Care must be used in filing catalogues, books, etc.

The Part That the Management Ought to Take in the Purchasing Department Operations

98. Considering the vital importance to success of a good purchasing department, it is singular how little attention the management pays to it. A weekly meeting of the general manager,

treasurer and other officials with the purchasing agent, members of the department and the stores keeper will do a world of good. The purchasing agent should report on (*a*) unfilled orders, amount and condition; (*b*) quotations—the officials can often help greatly in this matter; (*c*) particularly on those items upon which prices exceed the allowable "estimated price."

99. (*d*) On the big buying the department should work up charts showing the flow of supply and demand during different periods of the year for, say, ten (10) years past, also showing the effect that foreign demands have had upon the situation. Then report upon domestic and foreign market conditions as of that date. Draw your inference from your figures and chart and then let the committee decide how, where and when to buy. Many an effective plan of shrewd purchasing can be worked out by getting the advice and co-operation of the company's officials.

100. (*e*) All items that are behind in delivery.

101. The stores keeper will report on (*a*) unfilled order; (*b*) any need for quick deliveries; (*c*) on all items that are over-stocked; (*d*) on old items that represent an accumulation of dead materials, and have this overcome; (*e*) also on all shop delays and causes therefor.

102. Any sensible man can see the great good that can be gotten out of such meetings. In this way the management gets a real *grasp*, a real *control* of the buying and store's end of a business.

CHAPTER XV

STORES DEPARTMENT

How to Determine Amounts to Keep in Stores—Stock Cards—Order Limit and Rush Limit—Their Use to Prevent Overbuying—To Prevent Delays—Ordering Materials—Prevention of Accumulation of Dead Materials—How to Run Stores—Finished Parts Stores—Reduction of Working Capital tied up in Stores—The Blanket Requisition—Co-operation with Purchasing Department.

The Factory Bank

1. Your stores department is your factory bank. In this you have deposited tens or hundreds of thousands of dollars in the shape of materials for which you have paid.

Watch as Carefully as Your Bank Account

2. It is fully as important to watch your dollars tied up in stores as those you have in bank. In fact, your dollars in stores will be lost more quickly than your dollars in bank without your knowledge.

3. Stores carelessly ordered and over-bought will mean large quantities of useless materials on hand, tying up working capital.

4. Changes in construction made without reference to quantities of materials and parts in stock and in process of manufacturing, all of which must be abandoned, results in large losses. These facts are not always brought out plainly as these items are not often promptly written off the inventory, but are carried along year after year, giving a fictitious value to the inventory.

12% of Total Capital Tied Up in Useless Material

5. In any stores department that has been operating for a period of 8 years or over, I have always found not less than 12% and more often 15% of capital invested in materials uselessly tied up,

materials and supplies wrongly ordered, materials and supplies over-ordered, great masses of the latter, far beyond the company's needs, lying on shelves, and more still coming in regularly.

Stores Underbought

6. Stores not bought in sufficient quantities, as is often the case, will cause countless delays in production, crippling your output because of non-supply of parts, causing your operators to stand around doing nothing for fifteen minutes here, a half an hour there, all of which the company has to pay for and which causes losses of thousands of dollars.

7. You are paying huge sums for the production of parts. The constant even supply of raw materials to the factory so that every worker may be supplied at all times and your assembly room never delayed because of lack of materials, becomes of prime importance.

The Functions of a Stores Department

8. First. The keeping in stores department at all times proper quantities of materials, and delivery of these to the factory in such quantities and at such time as to eliminate delays and keep the operators working constantly.

9. Second. Avoidance of under ordering so as to prevent any possibility of a shortage of parts due to lack of materials when needed. Such shortages are serious and cause great losses.

10. Third. Avoidance of over ordering so that working capital will not be tied up uselessly in slow moving stock. A common situation.

11. Fourth. Keeping in close touch with sales and factory conditions that may cause a product to be changed or abandoned so that the parts in stock (raw and finished) and in process of manufacture, may be used up before the changes come; also, to cancel all outstanding orders for similar materials. I have known many cases where such changes have been made—the stores and purchasing knew nothing about it; no effort made to use up parts in factory; no outstanding orders cancelled; useless materials still pouring into shop until someone discovered the situation by chance.

12. Fifth. Keeping in close touch with sales department plans so as to know what their wants will be and place orders in ample time to secure materials for any increased demands.

13. Sixth. Keeping *accurate records* of amounts of materials on hand at all times, thus providing for a simple, perpetual inventory.

14. Seventh. Requiring properly signed and approved requisitions for all materials and supplies before delivery of them.

15. Eighth. Arrange the system so that:

(*a*) When materials and supplies fall down to a certain predetermined figure, then *orders wili be automatically placed* with the purchasing department.

(*b*) When materials and supplies continue to fail and reach the dangerous or rush condition, that this will be automatically shown so that *purchasing department may be* RUSHED in order to get materials in the shop before shortage causes shop delays.

16. Ninth. Keeping of materials in such condition that they will not deteriorate for any reason.

Anticipate Your Trouble

17. It is in the stores department that trouble must be anticipated. The stores department must do *their* worrying over *shortage of materials* before the factory ever feels it. If the shop runs out of raw materials, the effect will not be felt immediately as the assembling room will continue production on parts in finished stores and parts in process. But, the day of reckoning will come. Finished stock will be depleted, work in process gradually run out, and then delays will surely result *until* the raw materials, fed into the shop, travels its long way through the factory until it trickles through to finished stores. Of course, these parts may be RUSHED through the shop, but this rushing of one part causes another part to be affected later.

The Chronic Shortage

18. Then the shortage of these parts often becomes a chronic condition. The factory capacity being originally planned (in machine tools, jigs and fixtures) to produce very little more than the number of parts required daily off of each operation, cannot keep up with the demand from the assembling department. And when their shortage becomes chronic with a large number of parts, then is the factory operating inefficiently and in a costly manner.

A General Factory Condition

19. This is a general factory condition and is more responsible for delays, loafing, high costs than any other factor in production.

The production department is time and time again blamed for failure to deliver parts when, as a matter of fact, the stores department has placed it beyond their powers.

The Machining Department

20. In many a shop the hard working foremen get blamed for the loafing that goes on in their departments when, as a matter of fact, they cannot help it. They require a certain number of operation to get the parts out, but *very often* they cannot keep their workers provided with materials as there is not enough coming through the shop. As a consequence, the men knowing this, loaf on their job for fear other work will not be coming along. Then one part after another is short and there is the continual shortage of one part after another with the consequent RUSHING of many parts through the shop in small quantities, tearing down and setting up one machine tool after another, all of which is thoroughly destructive of efficiency. This situation is almost chronic in American factories. Any capable production engineer will look after this question amongst the first when reorganizing any shop.

Eating Up Working Capital

21. Anyone can run a stores system by ordering in great quantities of materials and absorbing from 50 to 60% more working capital than anticipated. It takes real method, however, to load up stores with "just enough" so as to avoid delays and keep down to a minimum the necessary investment and, at the same time, keep the system simple and this departmental cost down to a reasonable figure.

How to Control These Factors

22. It is, therefore, important that the methods control the keeping on hand and the ordering of enough materials (and only enough) to supply the shop steadily.

When to "Order Fresh Supplies"

23. The time required to get in new materials will determine the time when new materials must be ordered. The *quicker* these can be gotten, the *smaller* amount you have to keep; the *longer* the time required, the *more* materials required. The time is made up as follows:

(*a*) Time required to get order through all the O. K.'s and purchasing department to producer;
(*b*) Time required for producer to fill order;
(*c*) Time required for shipping, inspection and storing.

How It Works

24. If you use 1000 lbs. of 1-in. cold rolled steel per day, and it takes

4 days to get order through all O. K.'s, purchasing department, to manufacturer;
5 days for producer to fill;
4 days for shipping, inspection, and storage;

you must place a new order for materials when you have 13 days' supply or 13,000 pounds on hand. Figure a 15% excess for safety and you have a total of 14,950 pounds supply as the minimum before reordering.

25. Or, take a case of special steel forgings with a usage of 500 per day.

4 days to get the order through;
3 days for manufacturer to get them out;
3 days for shipping, inspection, storage.

Then when the quantity on hand drops to a 10 days' supply or 5000 plus a 15% safety margin, or 5750 forgings, a new order must be placed.

The Amount to Order at One Time

26. The amount to order at one time will depend upon the gain in price made by purchases in large quantities over that paid for smaller quantities; this being balanced against:

The lost interest on the extra investment;
Liability of material to deteriorate;
Liability of material being abandoned;
The ease or difficulty of securing prompt deliveries is also a factor.

Tendency to Order Too Much

27. The tendency is to order and keep on hand too much materials. When this is done on a large number of items, the tie-up of capital is often far in excess of that originally contemplated—there is a heavy loss in interest—and where changes in production are made the abandoned stock list becomes very great.

28. These points show the savings that can be made by dealing with shops close at hand who can give proper service, thus saving shipping time, for then you need not keep so much on hand; also, the buying of standards which can be secured quickly.

29. They also show the importance of getting purchase orders O. K.'d promptly and not allowing them to accumulate for days on various officials' desks.

When Just Enough Is Ordered

30. When the ordering is kept down, as it should be, then there must be close co-operation between stores and purchasing departments and vigorous following up of orders all along the line. This co-operation seldom prevails, but these two departments must be given to understand that they must work together and will *jointly* be held responsible for any errors.

Determining the "Order Limit"

31. When the quantity of any material gets down to where only enough is on hand to last until a new lot can be gotten in, then it is time to order a new supply. This quantity is termed the "order limit."

32. In the case of the two examples given the "order limit" on the cold rolled steel stock was 14,950 lbs., and in the case of the steel forgings the "order limit" was 5750 forgings. When these materials dropped to such amounts then a new order must be placed *at once.* The *amount* of this new order to be determined by the advantage of buying in large or small amounts as discussed in paragraph 26.

33. In case shipments by manufacturers are made on a regular schedule, care must be taken to see that this does not result in a big over-accumulation of stock. These "order limits" are still necessary as will be shown later.

Determining the "Rush Limit"

34. It is dangerous to place an order and then pay no further attention to it. In order that delays be prevented it is necessary to establish a further lower amount that is the *"danger limit,"* and that shows that the particular materials reaching this point must be *"rushed."*

35. These points are called the rush limits. These are ordinarily

established by adding together the shipping time (which, of course, remains the same) to from ½ to ⅔ of the time required for the manufacturer to produce and multiplying this by the daily rate of consumption.

36. In the two cases referred to, the "rush limits" would be 4 days plus 3 days = 7 days times 1000 lbs. = 7000 lbs., and 3 days plus 2 days = 5 days times 500 = 2500 forgings.

37. When any material reaches these danger points of the "rush limits" then Stores and Purchasing must keep after the material

NATIONAL MANUFACTURING CO BIN NO. 247

KIND OF MATERIAL Steel Forgings - H-45
USED ON No. 60 Reg. and No. 135 Reg.
CONSUMPTION (DAILY) 500 on No. 60 - 400 on 135 - Total 900 Forgings.
ORDER LIMIT 14720 RUSH LIMIT 6000
AMOUNT TO ORDER AT ONE TIME 30000

DATE	RECEIPTS	DELIVERIES	REQUISITION NUMBER	ON HAND	ON HAND CHECKED		NOTES
					DATE	BY	
1/6/19				10000			
1/8/19		4000	1468	6000			Rush
1/9/19		2000	1839	4000			Rush
1/11/19	10000			14000			
1/12/19		3500	1920	10500			
1/13/19	20000			30500			
1/15/19				30460	1/16/19	COOK No. 4217	

FIGURE 52.—Form for Stock Bin Card, Refer to Paragraph 37

unmercifully. *Under no conditions* can the shop be allowed to go without its standard quota of materials from stores.

THE BIN STOCK CARD

37. The one important though simple record in Stores Keeping is the "Bin Stock Card." This card shows the receipts of all materials—their deliveries—the inventory—the order and rush limits—thus forming a guide *when orders shall be placed*—when *rushed*—how *much* is on hand. Through these we locate the materials that are abandoned or which are over bought. See Figure 52.

38. This card contains:
   1. Material—kind and size.
   2. What it is used on.
   3. Consumption, so that as it varies it can be noted and changes made accordingly.
   4. Order limit, determined as per paragraph:
      (Before placing any order reference to the order record must be made to see if unfilled orders already placed will or will not take care of the situation.)
   5. Rush limits, determined as per paragraph No. 35.
   6. Amount to order, determined as per paragraph No. 23.

39. The columns perform the following functions:

Date Column, gives the date for each transaction noted.

Receipt Column, gives record of every receipt with date in date column.

Delivery Column, gives record of every delivery to factory with date in date column.

Requisition No. Column, gives number of each requisition upon which material is delivered.

On Hand Column, shows a record of amounts on hand. This is to be filled out each time a delivery is noted, the amount being secured by subtracting the amount delivered from the previous "on hand" figure. *This figure is vital —must be correct—must be kept up.*

Checking Column, gives date and by whom "on hand" figures are checked against actual inventory count, this figure, being placed in "on hand" column directly below last figure.

Notes, provides column for general comments such as when new order placed, rushing, etc.

Example

40. This card is for Bin No. 247 on Steel Forgings H. L. 45—used on registers No. 60 and No. 135—with a daily consumption of 500 on No. 60 and 400 on No. 135, or a total of 900 per day.

41. Considering 4 days for order to reach manufacturer, 8 days for him to fill it, 2 days to ship it in, we have 14 days which, with a 900-per-day consumption and a 15% safety factor, gives 14,720 for the order limit and 6000 for the rush limit, as shown in the proper place. The 30,000-pound amount to order has been determined as the most economical owing to special prices on quantity.

THE COLUMNS SHOW THE FOLLOWING TRANSACTIONS

42. On January 6th there were 10,000 pounds on hand; on January 8th there was a withdrawal on Requisition No. 1468 of 4000 pounds with an On Hand of 6000 pounds. This throws it into the "rush" class and stores department immediately gets after purchasing department and keeps after them until the material comes in. On January 9th there is a further delivery to factory on Requisition No. 1839 of 2000 pounds, reducing the "on hand" to 4000 pounds—still urgently RUSH.

43. In the meantime the purchasing department rushed in 10,000 pounds, arriving on the eleventh, which shows in the received column, increasing the "on hand" to 14,000 pounds.

NATIONAL MANUFACTURING CO.
STORES ORDER RECORD

MATERIAL-KIND .... DESCRIPTION ....

USED ON (GIVE QUANTITY) ....

.... TOTAL MONTHLY CONSUMPTION ....

AMOUNT TO ORDER AT ONE TIME ....

AVERAGE TIME REQUIRED TO GET IN MATERIAL .... ORDER LIMIT .... RUSH LIMIT ....

DATE	AMOUNT OF ORDER	REQ'N NO.	PURCHASE ORDER NO.	DATE APPROVAL	AMOUNT MATERIAL IN STORES	WILL LAST	DELIVERY NEEDED	DELIVERY PROMISED	RECEIPTS OF MATERIALS						
									DATE	AMT.	DATE	AMT.	DATE	AMT.	TOTAL

FIGURE 53.—Form for Stores Order Record, Refer to Paragraph 44

On January 12th there was a further withdrawal on Requisition No. 1920 of 3500 pounds, reducing the "on hand" to 10,500 pounds.

On January 13th the 20,000 pounds, making up the order for the full 30,000 pounds, arrived making "on hand" 30,500 pounds.

On January 15th, according to regular routine, stores man Cook, check No. 4217, inventoried this and found the "on hand" to be 30,460 pounds, which figure was inserted in the "on hand" column with Cook's name and check number in the checker's column.

The average store keeper cannot see the use of so much red tape," and is prone to deliver materials without requisition, or

neglect to keep up an accurate inventory, make mistakes on the bin stock cards, fail to report "order and rush items."

44. This stores order record, Figure 53, explains itself. Each order as placed is entered thereon with requisition number, purchasing order number, date of approval, amount on hand, etc. When deliveries come in these are entered along the same line bearing the proper order number. The series of columns is provided for registering partial deliveries. Thus the exact condition of any unfilled order is seen at a glance and the necessity for a new order noted.

45. If an order has already been placed then the purchasing de-

STORES ORDER REQ. NAT'L MFG. CO. DATE ....

MATERIAL REQUIRED ....
ACCORDING TO SPECIFICATION ....
WHERE USED ....
AMT. TO ORDER AT ONE TIME .... ORDER LIMIT .... RUSH LIMIT ......

AMOUNT TO ORDER	AMOUNTS ON ORDER BUT UNDELIVERED	AMOUNT ON HAND	MUST BE DELIVERED BY	

	DATE
O.K. STORES	
O.K. FACTORY MGR.	
O.K. TREASURER	
O.K. PURCHASING AGT.	

Purchased From ....
Delivery Promised ....

FIGURE 54.—Form for Stores Order Requisition, Refer to Paragraph 46.

partment is notified that action must be taken to get in the material on orders.

46. If a new order is needed, then this will be made out on the "stores order requisition" and then sent to proper parties for approval and to the purchasing department to order. See Figure 54.

47. The moment the amount in the "on hand" column shows near the "rush limit" then the *danger point* is reached. The stores immediately notifies the purchasing department on Form "RUSH IN MATERIALS." See Figure 55.

48. The factory manager should insist upon daily reports from the purchasing department covering these rush items. His insistence upon reports—which can be made upon the slips themselves—will rivet the attention of the Purchasing Department upon the necessity of getting in these dangerous items.

49. The purchasing department has before it a continual guide in its getting materials into the shop. Its "follow up" system described in Chapter XIV on purchasing department will provide for the active tracing of the orders when and after they are placed; therefore, when the danger signal "RUSH" comes in, there will be on hand accurate information covering the progress the manufacturer is making. If the need appears imperative, then quick action can be taken to get prompt results.

50. This method again "TAKES CARE OF THE LITTLE TROUBLES BEFORE THEY BECOME BIG ONES." It saves money in telegraph, tele-

RUSH IN MATERIAL NAT'L MFG. CO. **SPECIAL ATTENTION**

DATE ....

Purchasing Department - The following Materials are URGENTLY NEEDED and MUST BE IN SHOP BY ....

MATERIAL ....

QUANTITIES ON ORDER .... DATE .... REQ. NO.

.... DATE .... REQ. NO.

PURCHASING DEPT. REPORT HERE .... DATE .... REQ. NO.

.... Signed ....

STORES

....

FIGURE 55.—Form for "Rushing Material, Refer to Paragraph 47

phone bills and charges for expressage or shipments rushed in at the last minute. Its chief function is to prevent delays in getting in needed materials.

THE ORIGINAL FACTORY REQUISITION

51. The stores department must never issue anything from stores without a properly signed requisition. The requisition may take several forms. One article to one requisition. See Figure 56.

REQUISITION FOR STANDARD PARTS

52. First is the requisition made out by the superintendent for delivery from stores of certain materials upon which he proposes to begin work to produce standard parts for standard products.

53. In some shops the Superintendent decides what shall be

started into work, this depending upon the conditions of the machine room and the advice of his stock tracers relative to the factory's needs. He fills out this in duplicate—keeps one copy—sends the other to Stores Department. When Stores sends in material it is well for him to make a notation of this receipt upon the original requisition. Stores gets a receipt for materials delivered.

REQUISITION FOR MATERIALS NAT'L MFG. CO. DATE..........

STORES DEPT.-DELIVER TODAY THE FOLLOWING MATERIALS TO ....DEPARTMENT

KIND..................SIZE..........QUANTITY..................

JOB NO...............

Signed..........SUPERINTENDENT...

REC'D DELIVERY....................

REQ. NO.................... *Copy for Cost Dept.*

FIGURE 56.—Form for Requisition for Materials from Stores, Refer to Paragraph 51

REQUISITION FOR STANDARD PARTS SENT ON SCHEDULE BY STORES DEPARTMENT

54. Another and a better practice on parts that are standard and which can be produced according to schedule, is for the *stores department to deliver to the machine room at stated regular intervals* the amounts of parts to be put through, thus not waiting for the superintendent to send in any requisition.

55. This is made out by stores department—sent in duplicate to superintendent. He receipts and sends back one copy and keeps the other. See Figure 57.

DELIVERING MATERIALS AT STANDARD TIMES

56. The delivery of materials at standard times by stores department has a number of advantages. This forces the superintendent to start his parts in a rotation which will bring the best results in production. Nothing can be overlooked. Best of all, the superintendent *must* get his materials moving or they will pile up on him. The piling up will make it evident that there is some cause for delay at the beginning of the jobs. The worst possible place for delays.

57. If, at any time, the superintendent needs materials to keep his machine tools busy and the schedule calls for no deliveries, he will then use the first form and get in needed stock.

Requisition for Contract Work

58. When the superintendent is calling for materials on a special contract then this must provide for a means of identification with the special order number covering this. See Figure 58.

MATERIAL DELIVERED NAT'L MFG. CO. DATE............

Mr.....................Superintendent
According to Standard Schedule we deliver to..........Dept.
Today the following Material to be put into work.
Material.................Size ....Quantity............

Job No. ....
Delivered by.................
Received by..................

Signature ....
Copy for Cost Dept. Stores Dept.

FIGURE 57.—Form for Stores Department Material Delivered, Refer to Paragraph 55

59. This contract number is important as when the data are sent to cost department, it is identified and can be properly charged.

The General Requisition

60. There is the requisition for general supplies which is self-explanatory. See Figure 59.

This Gives Control

61. This simple system provides a strong, well-knit method of controlling the stores. I do not show any method of tying up the stores with the general books as this is a matter of proper accounting. This involves a large amount of overhead expense which many concerns cannot afford. This method is effective and costs but little. These are a few points that must be observed.

Character of Men for Stores Work

62. The head of stores department holds an important position

and should be a good man. It is evident that the job is largely one of simple accounting and therefore, this man must have a "nose for figures."

63. I have found it wise to call together the men in the stores department, explain to them carefully the necessity for keeping these simple records correctly, and give each one *written instructions covering his duties.* Accuracy must be insisted upon. Too much depends on it to tolerate for a moment any habit of inaccuracy.

The Perpetual Inventory

64. The keeping up of the inventory in the "on hand" column is the vital point for the entire method depends on this. The

SPECIAL CONTRACT MATERIAL REQUIRED — NAT'L MFG. CO. — DATE ____________

Stores Dept. = Deliver to-day to ________ Dept. the following Materials ____

____

to apply on Contract No.

Signed ____________ Super.

Copy for Cost Dept.

FIGURE 58.—Form for Material Delivery to Special Contract, Refer to Paragraph 58

average stores keeper is liable to be careless in making his entries, this coming from lack of understanding of their importance. He must be taught *never* to leave a bin from which he has removed materials until he has made a careful and legible entry of "delivery" and of "on hand" in the proper columns.

65. He must be taught to look in the bin every time he takes out materials and compare the "on hand" record of contents with a rough estimate of actual contents, reporting immediately any obvious difference.

The Checking of Inventory by Rotation

66. Each stores keeper must be given certain bins of materials, the contents of which he is to count during the month by counting certain bins each day, entering the amount shown by this count on the bin stock card in the "inventory check column," marking down date and his name.

67. The amounts that they find as on hand is to be placed in the "on hand" column directly opposite their name. If there is any big discrepancy, then an *immediate* investigation of requisitions must be made to ascertain who is responsible for the error.

68. The bins that each store keeper will check up each day will be so apportioned that the entire contents of stores will be checked each month. The stores men always have enough idle time to allow them to do this. This provides for an easy method of insuring accuracy in your "perpetual inventory."

70. In some concerns the stock cards are kept in the office instead of at the bins, entries being made from requisitions turned in. Trouble arises here from lost requisitions and the continuous

SHOP REQUISITION NAT'L M'F'G CO., DATE..............

STORES DEPARTMENT: DELIVER TODAY TO.......................THE FOLLOWING MATERIAL

WHAT WANTED	WHAT FOR	CHARGE TO
		(To be Filled out by Stores) For Cost Dept.

Material Received ....

Signed.......................Foreman

" ....Superintendent

Copy for Cost Dept.

FIGURE 59.—Form for Requisition for General Supplies, Refer to Paragraph 60

check of actual contents *vs.* recorded contents is lost. The records are kept cleaner and more legible, but mistakes from lack of accuracy must be guarded against.

Keeping Down the Abandoned Stock

71. Changes in production often require the abandoning of materials. Dropping off of sales will cause a lessening demand, or actual abandoning of some product will cut it off altogether. The usual big accumulation of such materials is an eloquent reminder of the fact that the stores department is seldom kept in proper touch with these conditions. I have known cases where radical changes in construction were made involving the non-use of costly materials—the stores department not notified—and they calmly going ahead and ordering the usual quantities of the old materials along with the new until the accumulation became very great.

Handling This Situation

72. No changes in production nor in sales plans that will involve abandoning of materials should ever be finally made until a survey of such materials is made as following:

A. How many parts and value in factory. (In process and finished stores.)

B. How much material and value in raw stock.

C. How many orders and value was placed that cannot be canceled.

73. With these facts before the management, the management can decide whether to build up enough product to consume such parts or abandon them. They then know what losses they face and can sell the materials at once if they decided to abandon.

How to Find Out the Amount of Abandoned Materials on Hand

74. To find out the amounts of materials now in stores that are abandoned simply call for the records from all bin stock cards that show no deliveries to the factory for 60 days.

75. These should then be gone over carefully and should be divided into:

A. Parts actually abandoned.

B. Parts for which the demand is dying out.

In the case of those actually abandoned, first cancel all outstanding orders, if any, then get into stores all parts that may be in the factory in process of manufacture—then arrange to sell it if it cannot be used elsewhere.

76. In the case of parts for which the demand is dying out, first find out the amounts in the factory in process of manufacture, then the amounts in stores, then the amounts on order, and lay the matter before the company officials. They can decide whether to sacrifice the investment or to finish up enough product to absorb these parts and put them on the market before withdrawing the sale from the public.

77. There may be another class that is made up of live parts, of which the shop itself is so full as not to have required any deliveries for 60 days, but these may be disregarded when ascertained.

Monthly Reports

78. The stores department should make reports to the factory

manager covering these items which had not been called for in 60 days, and also those which show as below the normal. The factory manager will then take this report up with the general manager and the sales manager so that proper business policies may be determined.

Discovering the Over-Bought Materials

79. Next in importance is the sifting out of those materials which are being over-bought. This is common practice and is bad not only because it causes a too large absorption of working capital, but also because it loads up stores and renders losses very heavy when changes are made and materials are abandoned.

Use the Bin Stock Card

80. First go to the bin stock cards and make up a list of those cards which show that for 60 days the materials on hand have not dropped to so low a point as to warrant placing a new order, notwithstanding regular deliveries to the factory. It is evident that, unless the case is exceptional, the ordering limits on such items *must* be too high and hence, too much material is gotten in at one time.

Report to Factory Manager

81. Report all such items to the factory manager every month and he will take them up with purchasing and stores departments and readjust the amounts to be ordered.

Report Rush Items to Factory Manager

82. Stores should report once a month to the factory manager as follows:

(*a*) The items that appeared on rush list.
(*b*) The items that caused delays.
(*c*) The items that had to be brought in by express instead of freight.

83. This is important. If too many items appear on these lists, then purchasing methods need overhauling. Often a purchasing department is obsessed with the idea that its function is to purchase alone—its other function is to GET MATERIALS IN ON TIME and it must be held strictly to account.

Purchasing vs. Stores

84. Purchasing and stores departments must be given to understand that co-operation is necessary, that no excuses for delays will be accepted and they will be held jointly responsible for results. In many concerns the head and workers in these two departments seem to have an idea that their chief aim in life is to "put something over on the other." They fight and quarrel and blame each other while the factory is suffering for materials. THEY MUST BE MADE TO WORK TOGETHER.

Unfilled Order Reports

85. Stores should make to factory manager monthly a report covering unfilled orders placed with purchasing department. This should show kind of material, quantity ordered, stores requisition number, monthly consumption, amounts on hand, specify especially all items near the danger point. Thus the management will have a guide in acting on this important material question. This is in line with my plan of "taking care of little troubles before they grow to be big ones."

FOR ANY SHOP TO RUN OUT OF MATERIALS IS A CERTAIN SIGN OF BAD MANAGEMENT. THERE CAN BE NO EXCUSE FOR IT.

The Factory Reservoir

86. Before closing this chapter on Stores, I must bring out one point that is usually neglected. If the factory is to be kept running —if the workmen are to be kept from loafing—then the shop must have in process at all times enough parts to keep up a steady flow. Every job in the shop must be kept filled up. Again springs up the important question of absorption of working capital. It is simple to load up a shop with tremendous quantities of materials that lie around for days and weeks between operations, eating up capital and interest charges, but it is a very different thing to put into the shop "just enough" materials to enable a skillful stock tracing department to guide all of it in and out of the factory mazes of countless operations, avoid delays, and make best use of it. Again, the stores department must work in close co-operation with the stock tracing department.

Finished Parts Stores

87. Between the machining division and the assembling room

stand the finished parts stores. The manufacturing of parts in large quantities makes it necessary to carry enough parts ready for the assembling department so that their supply is always constant.

Effect of Shortage

88. Nothing is more destructive of good production or more costly than having an assembling department wait on finished parts. And yet, this is a common factory condition. It costs any company very large sums to bear up under methods that cause assembling delays. Here, too, ASSEMBLING ROOM DELAYS IS PROOF OF BAD MANAGEMENT.

Operation of Finished Parts Stores

89. Finished parts stores are run on the same general plans as the raw stores. A separate room must be provided. Each class of parts must have its own place or bin. The same condition of under-supplies or over-supplies apply here as in the case of raw stores.

The Work Limit

90. The reaching of the "work limit" in the stock in the bins, as shown on the bin stock card, indicates that then the point of supply has been reached where the factory must begin to work on these parts and start them toward the finished parts stores. This work limit is determined by the average length of time required to get parts through the shop multiplied by the daily consumption. Of course, this average time will vary with the different parts.

91. For instance, if the daily consumption of one part *F*-63 is 2000, and it takes 8 days on the average to get work through the shop, then 16,000 will be the work limit. When this amount is shown on the card the stock tracing department will then look up the location of these parts in the machine room, getting this from the production reports.

92. If they find the parts located far from stores, they then order the foremen to begin work at once in order to get them up to the finished parts stores in time.

93. If they find the part *F*-63 located in some machine department near the final operation they then may not order these parts worked on if any others are more pressing.

94. Wherever these may be, however the stock tracing department moves them up toward finished stores so that there will be no danger of a shortage.

The Rush Limit

95. The rush limit indicates the danger point. Usually it is established at 35% of the work limit. This, however, depends upon the number of operations and their difficulty. In the case shown the rush limit would be 5600 parts.

Operation of the Rush Limits

96. Whatever parts get on the rush limit, those have THE RIGHT OF WAY OVER EVERYTHING. The stock tracer's authority (under the superintendent) is absolute. A foreman may have spent hours in setting up one job when along comes the stock tracer and gives him written instructions to start something that has shown on the rush limit, requiring this machine tool. There can be no arguments allowed. Down must come that set up and on must go the rush job. This is fully described in Stock Routing and Tracing.

Under-Supplies

97. Items appearing often on the rush lists must be thoroughly investigated. A constant shortage may be caused by:

A. Not enough material in shop to take care of numerous or slow operations.

B. Insufficient jigs or fixtures.

C. Poorly designed tools causing slow output and excessive scrap.

D. Not enough or poor quality machine tools.

E. Tolerances so close as to limit output. They may be increased upon investigation.

F. Poor operators.

Report to Factory Manager—Rush List Items

98. All items appearing on the rush list week by week must be reported to the factory manager, his attention being called to chronic cases. It is always astonishing to see how a constant and aggravating shortage can be cleared up if once the condition is pointed out, investigations made, causes remedied. Very simple, but saves endless trouble.

Locating Over-Supplies

99. Examine cards once a month and locate those that have had

so much material in finished stores that for 30 days there have been no calls to start parts. Then look up quantity in process of manufacture, add them together, compare with amount on "work limit," and determine whether or not to cut down on putting similar material into the shop for a proper and safe period. On certain parts such as small screw machine parts, the quantities will naturally be large, but aside from these, the shop will often be found to be over-loaded with parts that are not moving and are not needed. Report all these findings to the factory manager once a month for his investigation.

THE BLANKET REQUISITION

Loss of Time in Getting Requisition Through

100. Entirely too much time is lost in getting requisitions through from stores to purchasing department. They go through the hands of one official after another. Each one looks at them in despair, hesitates to approve anything he does not know about, has an uncomfortable idea that too much is being bought and cannot prove it, finally approves them in the blind hope that everything is all right after delaying them for several days. By the time they have passed through three or four hands, a week has been lost, and this is often enough to make a situation very serious, *especially* when the stores are being held down as closely as they should.

Effect of Every Day's Delay

101. I have shown that for every day's delay there must be provided for stores a day's supply of materials. Therefore, this is serious. At the same time, the fears of the officials are often well grounded, as is shown by the yearly balance sheet indicating that a large proportion of the year's profits have been absorbed in increases in inventory.

How to Control This

102. I control such situations in the manner to be described. At first glance, this may seem to involve considerable detail, but remember that this work need be done only once (modified as sales and production conditions are modified), and when done will prevent over-buying, give the management a clear conception of financial requirements, simplifying the O. K.'ing necessary.

The Material Survey

103. The entire plan consists of first finding out what the production program on each article manufactured will be for a period of at least four months. Then prepare one large blanket requisition covering all of these requirements, minus the amounts already in stores, show both quantities of materials and amounts of money involved so that officials can see both. Then submit this for approval to all officers.

104. The officers examine it, consult on the big purchases involved, use every means to assist the purchasing agent, finally approving this when satisfactory.

The Checking

105. The *checking* of the actual requisitions and purchase orders following this from both stores and purchasing department is done by the treasurer who holds one of the approved blanket requisitions. He prevents the ordering and purchasing of any more materials than those approved. No further approval by the officials is necessary.

106. First Step. Get from general manager and sales manager the production of each product required for four (4) months ahead.

107. Second Step. Get from proper sources—engineering department or designing department—a complete list of materials with quantities required for such a four (4) months' production on each of the products, putting this on proper report form.

108. Third Step. Combine these materials on the different products into one report showing the aggregate of each material required for all products for four (4) months' run.

109. Fourth Step. Deduct amounts of such material that are on order already or that are in stock in excess of orders limit requirements. These may be applied to these orders.

110. Fifth Step. The balance will show what has to be ordered of each class of material for delivery in four (4) months' run to meet production requirements. If any increase in production over the past four months is required, then the larger bulk of deliveries must be called for early in the period in order to fill up the jobs in the shop to care for the increase.

111. Sixth Step. These forms are then sent to purchasing department who will promptly fill out tentative prices based upon previous quotations at hand. When these are extended then there

will show a complete exhibit of the probable expenditures for materials (direct) for the next four (4) months.

112. SEVENTH STEP. These are then laid before the officials of the company, the general manager, the treasurer, the president and other officials for discussion and approval. When the large aggregate sums are seen then the officials realize the value of a good purchasing policy. Each will consider his connections in the business world and will help the purchasing department by exerting his influence to get better prices and service.

113. The purchasing department will buy to better advantage in price and service by placing large orders (subject to price fluctuations) calling for regular deliveries.

114. The treasurer, seeing these prospective purchases, knowing his probable payroll and overhead expenses, can calculate his financial requirements accurately.

115. EIGHTH STEP. The officers approve this blanket requisition and this is the last time they are ever bothered with another requisition for standard materials. One approved copy is sent to stores, this copy having no prices; another copy is sent to purchasing department; another copy to the treasurer who is to do the checking; the fourth copy retained by the general manager. It is important to note that during this period the purchasing department have been securing quotations and delivery promises.

116. NINTH STEP. The stores department, with this as its guide, issues its stores requisition as usual. These go directly to the treasurer who checks them one by one as they come in against the amounts shown on the blanket requisition, so that any excess can be stopped at once. The reason for following the plan of having stores issue the regular requisition in the usual way is to prevent any sudden ordering in too large quantities. The carefully planned, regular system will take care of this material. After the treasurer approves the requisition, it is sent at once to the purchasing department.

117. TENTH STEP. The purchasing department, having by this time gotten its prices, terms and deliveries, and determined its sources of supplies, now makes out four copies of the purchase order—one without price. These then go to the treasurer who immediately checks the *quantities* and *prices* against the original O. K.'d blanket requisition. The treasurer thus blocks any overbuying. Should the prices on the purchase orders be in excess of the original estimated ones shown on the blanket requisition, then the purchasing department must explain the reasons.

118. ELEVENTH STEP. At this point the cost department is called in to compare the proposed prices with the ones used in the cost calculations and especially note those upon which the sale prices are based, whether these be estimated or actual. This one thing alone has rendered necessary some astonishing revisions of sales prices and sales policies at times.

119. TWELFTH STEP. When the treasurer is satisfied with the quantity, price and delivery conditions, he immediately affixes his approval to all these copies. Retaining one, he sends the one without prices to stores, the two with prices to the purchasing department, one of which is sent to the manufacturer, the other retained by the purchasing department.

THE RESULT

120. This is all much simpler to do than may at first appear. The data for it should be at hand in any concern whether well or badly managed. After it is once gotten out, the carrying out of the details is simple. It gives the officers a real grasp of the situation; it prevents loading up with too much material; it leads to the securing of best prices; it saves all annoyance in O. K.'ing; it helps the treasurer.

CONTRACT WORK

121. The same plan should be carried out on contracts or special work. Here it is very simple and equally important.

THE CONFERENCE

122. At least every two weeks there should be a conference of the general manager, sales manager, treasurer, factory manager, purchasing agent, head of stores, to go over thoroughly all the items given herein. The monthly reports required are especially valuable.

THE RESULT

123. These simple methods, adapted to the factory conditions, will insure a proper limitation upon purchases and stores, will eliminate delays, produce and release working capital, prevent accumulations of dead materials. They have been used where the inventories were small amounting to sixty thousand ($60,000); where they were large, amounting to over three and one-half mil-

lion dollars ($3,5000,000). They have always worked perfectly when the right men were put in charge.

124. They will take care of any situation, no matter how complicated. In the last instance when they were used, there were employed over 9600 workers. The cost of these methods was very low and, coupled with the stock routing and tracing methods resulted in an effective system.

125. THESE METHODS GIVE THE MANAGEMENT A REAL AND COMPLETE CONTROL OF THE MATERIAL SITUATION.

CHAPTER XVI

COSTS

The Cost Department as a Cost Reducer

Its Functions as—A Cost Reducer—Determining Sales Prices—Locating the Profitable and Unprofitable Products

1. A well-run cost department covers many extremely important functions that are not usually attributed to it. The mere ascertaining of actual cost means but little, unless the details are followed up in such a manner as to bring about a reduction of costs.

2. *A*. It shows what the different products are costing.
   B. By making a proper comparison it demonstrates what products are the most profitable and what unprofitable, and enables the management to determine a sales policy.
   C. It enables the sales department to determine the basis upon which to set prices, due consideration being given to competition conditions.
   D. Locates unerringly those points in production which are highest in cost, thus enabling the management to concentrate their attention upon such high cost conditions in order to reduce them.
   E. Its records will always show where the greatest wastage from scrap occurs.
   F. When the cost is extended to cover the cost of selling (usually a much neglected point), it also shows what products are absorbing most of the sales cost.
   G. Its record also gives the exact location of parts that are in process of manufacture at any time.
   H. Its records provide a perpetual inventory of the work in process.
   I. Its records also provide important data for the production manager on daily production.
   J. Its records also give a simple method of establishing individual efficiency records for all employees.

3. The above program looks like a very imposing one, but I

wish to emphasize the fact that all of it is built up in a simple manner, especially when the systems involved are developed along lines designed to cover all these points.

Where the Cost Department Should Be Located

4. This is a much more important factor than it appears at first. In my opinion, the cost department, to be most efficient, should be the right-hand tool of the *factory management* in order that he secure important information concerning production efficiency and points of attack for reducing costs. Its functions deal so much with production that undoubtedly, in order to get the best use out of it, it should be under the strict control of the factory management of the company and *should not* be in the accounting division. I consider the cost department as being far more a *production tool* than an adjunct of the accounting system.

5. Where the cost department is under the control of the factory management, the data will be developed from the production and efficiency standpoint and the factory manager and the superintendents will be able to get their all-important data from it and get it promptly.

6. When, however, the cost department is considered mainly as an accounting proposition and is placed near the office then it is impossible, in spite of what anyone may claim, for the factory management to get with sufficient promptitude the production data that they need every day. Its data will be developed then from the accounting standpoint and will not be built up in such a manner as to provide proper efficient data. In all my experience there has not been one case where the cost department, when considered as an adjunct to the accounting department, has been of practical use to the factory management; whereas, it should be considered as the factory manager's tool for efficient production.

7. If the management insists that the cost department should be under the accounting division, then the production data referred to previously must be gathered by the factory management itself. This involves a duplication of work. I will, therefore, deal with the cost department as though it were under the control of the factory management, and will show the features of it that are not usually considered as a part of the costing and yet, are vital to a business man.

Costs on Each Product

8. Each product manufactured should have its costs figured just

as far as may be possible, as though it were being made in a separate factory. The importance of this is obvious when you consider that your company may be manufacturing four different products and you may be in competition with other concerns, each of which is handling only a single one of these lines. It, therefore, is of importance for you to know how much each of your products is costing in order to know how to compete.

The Problems of Costing Can Be Divided Into Two Large Divisions

9. The first is a collection of direct cost of material and labor, and the second is a collection of overhead or indirect costs.

10. Direct costs refer to such materials and such labor as are properly and easily charged directly to the job to which it is applied. As much of the labor and material on any piece of work as possible should be charged to the direct cost and *not* thrown into overhead.

11. Indirect cost comprises indirect materials and indirect labor.

12. Indirect materials are such as coal, oil, small tools, waste, etc., that cannot usually be charged against any particular job. The indirect labor comprises that labor that cannot be charged against any particular job, such as salaries of superintendents, foremen, truckers, sweepers. Other indirect charges come under insurance, taxes, depreciation, maintenance.

13. This chapter will deal principally with the two following very important subjects:

14. (1) The collection and use of the data in connection with direct cost by which the management can keep in close contact and a close control of production conditions.

15. (2) The collection of the data relating to the indirect cost and its distribution by methods which will distribute against the different classifications of work a proper proportion of this overhead charge. This latter is a matter of the greatest importance for generally the overhead charge is larger in amount than the direct labor and an incorrect method of apportionment against the different classes of work (as generally results from present methods) will lead to erroneous conclusions of a serious character.

16. Later in this chapter I will give illustrations of two cases of my experience where an incorrect method of apportioning overhead against different products led to costing that were misleading and, as a result the sales department pushed the sales of those products upon which the company was losing money and

neglected the product upon which the firm was making a profit, thereby almost driving the firm into bankruptcy.

17. My experience shows that this condition is very general, and a close study of this question of the proper method of apportioning overhead must be made by any management before they can expect to get their factories in an efficient condition.

Avoid Detail

18. One man may have no cost data at all, and is, of course, in a bad condition for he cannot possibly know what is going on in the shop. Another man may be burdened with an enormous amount of cost detail that no one pays any attention to. His cost department is costing too much and the mass of data is made up of figures that are repeated over and over again, and that are largely meaningless as a source of important information to the management.

19. A cost department must justify its existence by the results of its work. Every set of figures coming out of it must bear a message of some kind and must show the management where there exist danger points, inefficient points, high cost points, and also indicate those points that are operating smoothly, properly and at a low cost.

Direct Costs

20. I propose to take the simple time and job ticket as laid out by the worker and from this build a real system that is vital in every division of it.

21. By a successful and simple use of the data derived from this time ticket we will:

- *A*. Show the cost of all articles by operations. From these data the high cost operations can be selected for investigation and proper methods can always be devised for reducing the excessive costs. This is the most important function of the cost department.
- *B*. Show the production by operations, indicating clearly the exact spots where production is falling down.
- *C*. Show the spots where excessive and unusual scrap is occurring.
- *D*. Build up the cost records so that they prove an effective check against the payroll.

E. Furnish a record showing the exact location of all materials in the shop. This is invaluable for use as stock tracing.

F. Provide a perpetual inventory of all work in process.

22. It should be understood at the outset that the methods suggested and illustrated herein, while they are of a type that have been used in large and small industries, still must be adapted to existing conditions.

23. In describing this cost system it will be necessary to develop also such details as "the proper making out of tickets," "the handling of them," and the materials they cover, etc.

24. We will start with this work of time and job tickets.

25. You will note that it shows the date, job number, number of parts worked on, number scrapped, number of parts accepted, time started, time finished, total time, rate of pay, total earned, operator's name and check number, inspector's name and foreman's O. K.

26. This form of ticket need not be followed out exactly for any form will be satisfactory if it contains the essential information.

NAT'L MFG. CO.

PART .... OPERATION ....

DATE ....

BOX NUMBER	TOTAL NO PARTS WORKED	SCRAP		TO BE RE-OPERATED	ACCEPTED	TIME			DAY WORK		BONUS		TOTAL EARNINGS	
		BM	BF			BEGUN	FINISHED	TOTAL	HOURLY RATE	TOTAL	BONUS RATE	TOTAL		

JOB BOSS .... PAY ROLL CLERK ....

INSPECTOR .... FOREMAN ....

DEPARTMENT .... OPERATOR ....

FIGURE 59-A.—Form for Operator's Job and Time Ticket

METHODS OF ISSUING TICKETS

27. Where the various departments are large enough to justify the expense it is best to have the departmental clerk make out these tickets and see that they are delivered to the workmen before they are ready to start on the next job and also gather in the old tickets for work already done. In many cases, however, the expense of these departmental clerks is too great. Therefore, the firm must decide whether the foreman or the workmen themselves should make out the ticket.

Workmen Should Not Make Out Tickets

28. There are two principal objections against the idea of having the workmen make these out. They will seldom take the trouble to fill in the time right. They are liable to wait until noon or night before they make out *any* tickets, and if they have been working upon a number of jobs, they are prone to divide their total time by the number of jobs, thus making tickets themselves valueless for computing costs. This one condition is a practice that is very usual and one that must be watched carefully. The other condition is, of course, the time wasted by the workmen in making out these time and job tickets.

Foremen Should Make Out Time Tickets

29. In factories where department clerks cannot be afforded, this work of making out the time tickets should be done by the foreman or one of his assistants. Of course, I understand that it will immediately be said in answer to this that the foreman should not be compelled to attend to such details. Yet, as a common-sense practical matter, I doubt if there is anything that will bring the foreman or assistant foreman *into as close touch* with the actual important details of his department as forcing him to look over and make out the time tickets.

The Foreman Must Know What Is Going On

30. The foreman should know just what is going on in his department and there is no better way to make certain of this than to force him to go over all these time tickets. This will bring him into personal contact with the job-bosses and operators, and will do much good toward promoting efficiency.

31. He must finally sign each and every job ticket turned in after completion of the work. When he does this and properly examines the tickets he himself will know the rate of production of his operators and will also see whether or not they are producing too much scrap. He, by making a comparison with his knowledge of standard hourly output and the actual output shown on the tickets, will himself note any serious fall down and can immediately investigate the reasons therefore.

32. When a foreman is forced to do this O. K.'ing of time tickets, and investigates every fall down revealed, he immediately learns more about defective tools, machinery needing repairs, short-

age of materials, shortage of tools, etc., than he had heard of before for months. There is nothing that will put him in such close touch with conditions in his department as to force him to see and examine all the time tickets.

Delivery of Time Tickets to the Workmen

33. In a previous chapter I have described a simple system where the materials should be delivered to each department, keeping it on proper platforms. I also described how the foreman was supplied with a list showing what work should be in his department that was of an urgent character and, secondly, what work was needed in a general manner, these lists giving him the proper basis upon which to operate.

34. The foreman, therefore, knows from these lists what is needed first. He, therefore, schedules up his machine tools, his workmen, his tools and his materials so that he may properly direct the operations in his department and know what work to go on and how soon it should be gotten out.

35. He first sees that the material listed up is waiting for his department on the proper platform. If this is not at hand, he will immediately notify the stock tracing department so that they can get it up to him.

36. He will get together the necessary tooling equipment for his workmen in order that the machine tools may be set up promptly for the new work that is coming.

37. In other words, it will be his business to see that each man in his department is provided with proper materials, proper tools and proper tickets.

38. After the work is done and the tickets are filled out, these tickets are placed in the holder on the side of the box or tray, and the work is then hauled to the out-going platform or bench. If the work is to be inspected before the next operation, it is routed for the inspection department. In case where it is to be inspected, the time ticket is sent to the cost department after inspection. If the work is to go to the next department without inspection, the workman's time ticket is taken up by the foreman and sent to the cost department.

39. The payroll clerk gets the tickets first and extends them, showing, of course, the amount of pay the workman is entitled to each time ticket.

40. Right at this point let me emphasize the fact that this ex-

tension of tickets must not be allowed to get *behind even one day*. For, if this occurs, then the whole system will fall to the ground.

41. It should be noted that up to this point we have done nothing more than that what every company must do in order to get its payroll.

42. Now, let us see what we have got in this collection of time tickets properly O. K.'d and extended.

43. I will show that by using the data on these time tickets and arranging them in different classifications or groups, we can get together a remarkable amount of valuable information.

44. We will first consider those conditions where standard work alone is handled, and then later on will take up the question of the handling of the work which will require job numbers such as contract work.

The Daily Output Records by Operations

45. It is of great importance to the up-to-date factory manager and superintendents to secure each day an accurate record of the output on the different important jobs performed the day previous. I have already dealt with this in previous chapters, where I showed how production reports should be collected. In cases, however, where the company is small this same result can be secured through the cost department's records if only the data are kept up to date. It will be seen that this can be done very simply by taking all the time tickets and classifying them in groups according to the part and the operation. From this you then have the record of the output of each part according to its operation.

46. The forms to be used in any business for the registering of direct labor cost are so essentially simple that no illustrations are needed. The recording of these, however, should be done in such a manner as to show distinctly where each lot of parts are located in the factory so that when production reports are not kept up, then these cost records will serve the purpose.

Locating the Difficulties

47. It is obvious that when the factory manager compares the *actual* output on any particular job with the output *necessary* to meet production requirements, he will immediately *locate the place* where there has been any serious fall-downs so that he can center his attention upon this point before any serious damage is done.

Stock Tracing

48. These particular records are of great value in the tracing of stock as they provide for the immediate location of all parts being manufactured in the factory. The stock tracer learns from the assembling room requirements and the conditions of the stock cards in finished stores exactly what parts are needed immediately and also what parts should be worked upon so as to avoid future delays.

49. By referring to this record he immediately establishes the location of all such parts and, therefore, knows just what department and what foreman is responsible. He is thus in a position to notify the foreman exactly what is needed out of his department and when it must be gotten out in order to avoid serious delays.

Entering Costs

50. The preparation of forms to be used for the entering of the labor costs need hardly be discussed. The differences in manufacturing conditions are such that it is useless to illustrate them. The proposition is simplicity itself if the cost man keeps in mind that his records must be built up so as to serve the very practical use of giving *data for cost reduction.* This means that on the principal parts especially, it is necessary to keep these *costs by operation on the different parts.* Keep in mind that you must be able to tell the factory manager or superintendents what any operation is costing at any time.

Locating the High Costs

51. When the cost figures are properly assembled it is an easy matter to select one part or any group of parts and determine the operations upon which the labor costs are high. This should lead to an investigation of a very thorough character; it can then be determined whether it is possible to reduce these costs either by improving the tooling, or get improved machine tools, changing materials, or changing the class of help.

52. I have suggested the plan of requiring the factory to investigate each month ten (10) operations on each product that are costing the most in order to ascertain if they can be reduced. This plan brings the question of reducing costs up in a very concrete positive manner. The ten (10) operations that appear to be

high in labor costs are laid before the superintendent who in turn takes up the questions with the proper foreman in whose department the costs occur—the head tool designer, the tool room foreman. Each item is gone over with great care and thoroughness and a written report submitted covering recommendations of what should be done in order to reduce these costs.

53. This method of arousing interest in cost reduction always results in the foremen taking a lively interest in the labor costs in their departments. They soon begin to send in suggestions showing how this cost can be reduced by getting an improved machine tool or can be lowered by a simple change in the existing tooling, or an explanation why a certain operation is costing too much in their department with suggestions how to lower them. This plan provides the best way to get the foremen thinking over possible cost reductions. They will know that they will be asked to explain why certain costs are high and they will strive to overcome them before being asked for such an explanation.

Entering of Costs in Special Contracts

54. It is, of course, clear that the handling of costs relating to special contracts will be handled in a similar manner.

55. Each contract, being properly numbered, will have its own distinct cost sheet. Each part of the product going to make up the whole will have its own sheet upon which the labor tickets shall be entered. If any number of these parts are of a distinctly minor character they can be bunched together, but each main important part must have a sheet to itself.

56. The workman's time ticket in addition to the name of part and other essential data will contain the number that has been assigned to the contract, this making it possible to immediately enter it upon the sheet assigned to that particular part under that particular contract.

Bringing the Different Parts to Assembly Together

57. These cost sheets will assume different forms according to the business. However, they should be so made up as to provide for a showing of detailed labor costs on each part together with the name of the department in which the work is done. In this way the *location* in the factory of the parts to any special contract can be determined at any time so that by a proper tracing method they can all be brought through to the final assembling together.

58. As stated before, any bright cost man can get up your forms to care for your particular situation.

Comparing Costs and Estimates

59. It is surprising to note how often there is no attempt made to compare the actual costs with the estimates upon which the contracts are taken. Yet nothing is of more critical importance than correct estimating and nothing more common than incorrect estimates. A comparison between estimated and actual costs ***must be made regularly***. From this a system of estimating will be built up that will prove reliable.

Distribution of Indirect Costs (Overhead)

60. This subject has been so thoroughly covered by other writers that little need be written here toward describing the various methods now in use. Yet the writer cannot let it pass without illustrating from an actual example the real danger a concern can run into when distributing overhead improperly.

61. In a case at point, the company was pushing the sale of the unprofitable product and neglecting the sale of that which would yield a profit, owing to the bad system of overhead distribution which falsely showed a too low cost on the first and a too high cost on the last product. The company was losing money heavily and could not locate the reason.

62. The products were two in number, each requiring entirely different manufacturing processes but handled through the same sales department. The overhead was distributed on the usual "percentage on labor costs." The total indirect charge was 125% of the direct labor charges. This overhead was made up as usual of (*a*) salaries of superintendents, foremen, clerks, designers, draftsmen, stock tracers, stores, watchmen, etc.; (*b*) tool room expense which were not charged directly to jobs; (*c*) inspection; (*d*) heat, light and power, including coal, salaries, wages, maintenance; (*e*) maintenance of plant; (*f*) depreciation of plant and equipment; (*g*) insurance and taxes on plant; (*h*) oil, waste, belting; (*i*) general expenses.

63. The average direct cost of the first product which was made up of special contract work was $1200 for material and $3400 for labor, the overhead at 125% on labor was $4250, making a total cost of $8850. At this price the company undersold competitors easily and ran up large sales.

64. The other product was smaller and standard. The average

material cost was $14, average labor cost $41, overhead at 125% was $51.25, making a total cost of $106.25.

65. This latter product was sold under strong competition conditions to agents at an advance of 35% on their cost or $143.43. This average price was so high that business dropped off until it was but 25% of that of previous years.

66. The sales of the first product, however, were so large that the aggregate sales were satisfactory, the factory working at night on much of it. But the company had lost over $140,000 in one year. They would call for their costs, and up would come the cost department with their detailed direct costs with their 125% overhead added. The total costs compared with sales prices appeared all satisfactory.

67. Upon taking hold of the situation I found the sticking point after a few walks through the factory. It lay in the incorrect distribution of the overhead, by *which the same percentage on labor was applied to both products.*

68. I found that the first product required 85% more floor space than the latter and, consequently, should have been charged with a greater proportion of the charges for taxes, insurance, depreciation on buildings, maintenance and light, than the latter.

69. The machinery investment was in the proportion of $229,000 for the first product and $70,000 for the latter. Three times as much, consequently, charges for depreciation, machine^c, maintenance and power should be in like proportion.

70. The first product required a greater expenditure for expensive tooling and up-keep than the latter.

71. The proportion of superintendence was greater.

72. In other words, I found that the last product was bearing a large proportion of the expenses of the first. Further, that while the additional sales of the first product would allow for an additional overhead, still the sales prices based upon such fictitious figures did not actually allow of a profit. There was, as is quite common, not a sufficiently frequent checking of actual overhead against the calculated overhead to detect the difficulty.

73. My first step was to consider each product as though it were built in separate factories, apportioning to each its own floor space, machinery, tool equipment, tool usage, maintenance, heat, light and power, salaries. I charged each product with its proper taxes and insurance based upon floor space, and depreciation and maintenance according to floor space, machinery and actual charges. I will show later the details of this method.

74. After making this survey I found that the proper percentage against the first product based upon a volume of business equal to the old was 167% instead of 125%.

75. That the proper percentage against the second line was 84% instead of 125%.

76. In the first case, the true manufacturing cost was $10,278 instead of $8850.

77. The cost of the latter article was $99.44 instead of $106.25.

78. The company thus faced a severe shrinkage in the first business, but could look to a large increase in business in the last product inasmuch as they had an excellent reputation and could sell this product at a price equal to or a little above their competitor.

79. A survey was made of the competitor's prices on the latter product and it was determined that the sales department could gather in a large business on a price to dealers of 40% above the average cost of $89.44 or $125.22, as compared with the old price of $143.43.

80. A study of the sales conditions showed that the sales expenses of the first product were greater than of the last. Therefore, it was decided to raise the prices on the first product, cut out the factory overtime, reduce sales expense and aim to get just enough business to cover all expenses with a minimum of profit.

81. As a result of this action the sales and expenses as well on the first product decreased and the sales of the latter product increased. The latter product also allowed of a quicker turnover of money expended, and as a result a yearly loss of $140,000 was changed in one and one-half years to a profit of $161,000.

82. If ever a business man wants a vital spot at which to direct all his acumen and shrewdness, let him point directly to this question of "distribution of overhead" which is usually so well hidden amongst all these cost figures presented. Just ask *one question:* How closely does this distribution of overhead represent the actual condition that would exist in regard to each product, if each were put into a different shop. Then study the answer.

83. Of course, when different products are put through the same department it is difficult to make such a separation, yet an approximate idea can be formed if only common sense is used.

84. The machine rate method of distribution will take care of such factors better than any other system, but many manufacturers fear the expense.

WHY A MANUFACTURER MUST NOT SPEND A USELESS DOLLAR

85. A man advocating any system must always bear in mind that the expense of two or three extra clerks means something to a man doing a business of say $400,000 per year on a 10% net margin. The three clerks will cost $3900 yearly. Figured at the 10% margin this would mean that the manufacturer would have to increase his business by $39,000, or almost 10%, in order to pay for these three extra clerks. If a man does a business of $100,000 yearly on a 10% margin, netting him $10,000, then a useless expenditure of $1000—which does not appear large compared to the value of $100,000—is 10% of his profit which *is* a large sum. Therefore, a manufacturer cannot afford to spend a useless dollar. Every one must count. On the other hand, he must spend enough to protect himself against a vital mistake such as I have outlined.

86. The method to be pursued is as follows:

Separate your different products into distinct groups. Then take your entire amount of overhead charge and divide it against each product, just as though each product were being manufactured by itself and were charged with its proper proportion of all of these charges only.

87. (1) HOW TO DETERMINE THE TAXES AND THE INSURANCE ON BUILDINGS; THE DEPRECIATION ON BUILDINGS AND PROPORTION OF MAINTENANCE CHARGES; THE EXPENSE OF HEAT AND LIGHT, PROPERLY CHARGEABLE AGAINST EACH PRODUCT.

These can all be considered as factors of floor space used for the production of each product for manufacturing, stores, general purposes. For instance, if your total floor space is 200,000 sq. ft., and the production of registers requires 50,000 sq. ft., it is apparent then that registers must stand one-quarter of all charges for taxes on building and land, insurance on buildings, depreciation of buildings, maintenance on land and buildings, charges for heat and light.

88. Therefore, ascertain your total floor space, then the floor space required for each product and get the proportion for each product.

89. Then get your total of taxes on land and buildings, insurance on buildings, depreciation of buildings, maintenance on buildings, of cost of heat and light, and then apportion this total in the same proportion as the floor space used. Thus you have the proper amount of these items chargeable against each product.

90. (2) TO ASCERTAIN THE DEPRECIATION, INSURANCE AND

TAXES ON MACHINERY AND TOOLS—GENERAL EQUIPMENT AND MAINTENANCE CHARGES PROPERLY CHARGEABLE AGAINST EACH PRODUCT.

Classify the actual value of machine tools and small tooling and equipment that is used to *produce each product* and then determine the depreciation to be charged to each product by applying depreciation to these values.

91. If maintenance charges are lumped then apportion the total amongst the classes according to the proportion of the value of the machine tools, etc., in each group against the total valuation.

92. The taxes and insurance applicable to machine tools and equipment should be distributed against the various products in the proportion that the value of machinery and tools and equipment on *each* product bears to the *total* valuation of machine tools and equipment.

93. (3) DISTRIBUTION OF COST OF POWER AGAINST THE DIFFERENT PRODUCTS.

The cost of power includes not only the cost of operating the power plant (i. e., labor, superintendence, coal, oil, etc.), but also the depreciation and costs of maintenance of the power plant itself. In cases where the power plant is a large factor then its cost including overhead should be considered as a separate item. Then this cost should be distributed against the different products in proportion to the *power used on each.*

94. (4) THE DISTRIBUTION OF OVERHEAD EXPENSES OF STORES, COSTS, STOCK TRACING, ORDER DEPARTMENT, ETC., AGAINST THE DIFFERENT PRODUCTS.

The proper distribution of these expenses will depend upon the character of the business and its products. In most cases the proportion of the volume of production will form a sufficiently accurate basis to distribute these costs against the different products.

95. If this will not be accurate then get the proportion of hours used on each production with total hours consumed (direct labor), and use this proportion in distributing the above costs.

96. (5) DISTRIBUTION OF TOOL ROOM, DESIGNING ROOM, PATTERN DEPARTMENT, ENGINEERING DEPARTMENT, AGAINST THE DIFFERENT PRODUCTS.

These expenses should be distributed directly against the different products. It is entirely wrong to throw drafting room or tool room expense into general overhead and distribute it against a product that requires only a small amount of tooling and no drafting or designing. In these cases, let each product carry its own burden.

97. (6) DISTRIBUTION OF SALARIES OF SUPERINTENDENTS, FOREMEN, CLERKS, ETC., AGAINST DIFFERENT PRODUCTS.

In some cases where the division of product is distinct, it is simple to charge each product with its proper amounts. But when the distribution is difficult, owing to one man supervising several products, then I divide the totals of such salaries against the different products by using the proportion in each case between the hours worked for one month on one product and the total hours worked on all products. For example, if the total time worked on registers for one month was 12,000 hours and the total time for *all* products for the same period was 60,000 hours, then the registers would be charged with 1/5th of the total salaries above mentioned.

98. (7) THE DISTRIBUTION OF GENERAL EXPENSE AGAINST THE DIFFERENT PRODUCTS.

The last-mentioned method in establishing a percentage of labor hours on each product against the total labor hours on all products will serve as a fair basis of computation.

THE WORKING OUT OF THIS PLAN

99. By this plan you will get the overhead properly chargeable against each product and can then establish the proper percentage of overhead that is properly applicable against each class of work. Usually, the difference between these percentages and those derived by the usual methods, and hence the differences in final total costs, will be astonishing. With these data before the management, they can correctly decide upon sales prices and a sales policy which will have a direct and beneficial effect on profits.

CHAPTER XVII

METHOD OF MANAGEMENT BY WHICH OUTPUT IS BROUGHT UP TO THE STANDARDS

The Importance of the Producers—The Foreman's Control—His Importance —The Control of Discharge—of Promotions—Locating the Inefficient—Developing Efficiency—Employment—Labor Turnover.

What Is the Big Factor in Success or Failure

1. Of all the factors that bring about either the success or failure of a business, what is the most important? What is it that looms away up above others? That when *working at high efficiency* will bring success with back-number machinery and poor systems? That when operating on a *low degree of efficiency* will wreck a concern with the best of equipment, buildings and systems?

Body of Producers

2. It is your *body of producers.* The men and women who operate your machine tools, and whose brains direct and fingers assemble the different parts in the assembled products; together with those who govern them, who instruct them in their work, who see that they are supplied with materials to work upon, who see that this work is done properly; the human beings who are producing—YOUR ORGANIZATION.

3. If the average employer had only five machine tools, five workmen and one foreman, he would recognize where his profits, his business success lay. He would know what the output of every one of these machine tools ought to be, and he would see that each one of the operators got out the proper amount of work. He would realize the importance of having that one foreman a *good* foreman, who would handle the men so as to get the most out of them and, at the same time, satisfy them. If he found one of the five workmen inefficient, he would either have him trained up or discharge him. If he discovered that one of the five was getting the best

jobs and rates without deserving it, or that one of the best workers were discharged without adequate reasons, he would not have to be told of the demoralizing effect on the rest and the evil effects on his production and costs.

4. In fact, there would be dozens of things which might happen in the shop life of the foreman and five workmen which would have a bad effect on his production, costs, and profits. And he would know that he would have to remedy them and do it promptly.

He Must Trust to Others

5. Now, how much easier is it for all of the causes of "inefficiency" to happen when he has five thousand workers instead of five, and seventy-five foremen in place of one. He cannot oversee all conditions. He must then TRUST TO OTHERS. He must "trust to others" to govern his shops, his workers, so that a full output per machine and per operator will be secured at a cost low enough to insure a profit, and by methods that will bring up the efficiency of the workers, properly reward the competent and industrious, and satisfy the labor by proper treatment and proper wages.

The Big Problem of Management

6. THE BIG THING IN MANAGEMENT IS FOR THE MANUFACTURER TO TRAIN THESE "GOVERNORS" OF THE SHOP, WHO THEN TAKE HIS PLACE, TO SO REPRESENT HIM AS TO BRING OUT THE FULL EFFICIENCY OF THE WORKER ON EACH JOB IN THE SHOP. HE MUST DEVELOP THE HIGHEST EFFICIENCY IN THOSE TO WHOM HE MUST ENTRUST ALL THESE IMPORTANT DUTIES.

Bringing Out the Efficiency of the Worker

7. After all, the problem of production swings around the production of the individual operator, whether they aggregate five or five thousand. The problem of organization and management is, therefore, far more than that of working up a relationship between the officials, the manager, the superintendent, the foremen, a defining of their duties, their responsibilities through little fancy charts.

What Organization Work Means

8. True organization work means the development of the full efficiency of each individual, whether superintendent, foreman or

worker, and of a spirit of co-operation that will lead them to work together for the good of the company. This involves the satisfying of labor with wage and conditions of employment, the training of the real governing force, the foremen and superintendents, and the development of harmony and a true spirit of co-operation amongst the superintendent and foremen which will uproot the usual antagonism, jealousy, and backbiting that exists in most bodies of foremen.

Study the Position of the Worker

9. As the operator is so important a factor in production, his position must be studied. Whatever may be the company's attitude and feelings toward labor still, in order to get proper results, it is necessary that the management study its own methods, and uproot and remove any that give their workers a *real* and *just* cause to feel dissatisfied and to harbor ill will against the concern. This will do much to establish a desirable feeling of confidence and will rob the radicals of much of their strongest ammunition. Therefore, a study of the worker's position must be made in order to get a true grasp on the situation—to see clearly the important relationship between the worker and the foreman—and then to work out the remedies.

Applying of Common-sense-ology

10. Let us, therefore, study the problem of management and organization in a common-sense way. We do not need to consider any problem in sociology or ethics or any other of the high flowing "ologies" that have been applied to the labor problem with such poor success. All we need is a good strong application of *"common-sense-ology."* We need to *get the point of view* of the *worker and the foremen* relating to the every-day shop problems that seem so unimportant to the officials, and yet, which are *vitally* important to the worker and his immediate boss because they affect so seriously their lives in and out of the shop. The whole problem revolves around old HUMAN NATURE that is so mule-headed when handled wrong—so reasonable when handled right.

The Real Governing Force in Your Factory

11. The factory management is divided into three groups:
First. The *official group* or the *company's officials.*

Second. The *governing group* namely, *superintendent, foremen and job bosses.*
Third. The *producing group* namely *labor.*

The Governing Group

12. The *factory governing group*—the superintendent and foremen, and more largely the foremen—are the *real managers* of the producing department; the *real interpreters* to the workers of the management's ideas and wishes. The workers are affected, *not* by the fine speeches and plans of the officials, but by *what their foremen do;* by their method of management. As one of my operators once said to me: "Mr. Carpenter, it's not the fine speeches and flowers and clean shops that count. It's what the foremen *do* that counts with us workmen."

13. Let us get firmly fixed in our mind that the foremen are the men who control the workers for all of their shop time, which is so large a part of their life.

The Control the Foreman Exercises

14. *He* decides who should be promoted;
He decides who should be discharged;
He decides who should have the easiest and best paying jobs;
He usually sets the prices or wage rates on the jobs;
He usually has the powers to reduce these wage rates as he sees fit;
He decides who shall have their day-work rates of pay raised and who shall not;
He is the one who actually *governs* the men and women in the department under him;
He, therefore is the FINAL INTERPRETER of the management's ideas and instructions to the workers at the machines or benches.

Any experienced production man knows that THE FOREMEN ARE THE MOST IMPORTANT MEN IN THE SHOP.

The Foremen Should Understand the Company's Policies

15. Inasmuch as the foremen are the *real* interpreters of the management to the workers, the *real* governing power in the shop, it is absolutely necessary that they understand clearly the com-

pany's attitude toward the management of the shop problems that affect labor.

16. For instance, instructions as to the firm's policy in handling employment, selections for work and keeping out relatives, discharges, prevention of unjust discharges, promotions, rewarding those who deserve it, training of workers to become more skilled, raising of rates based on merit, whether rates of pay should or should not be cut arbitrarily when the worker exceeds the average earnings. Strangely enough, these men usually are placed in these jobs and allowed to develop their own methods of management—all with their lack of experience, their natural tendencies to swing toward being too harsh or too easy on vital points, and all guessing whether or not their particular methods are in accord with the company's management.

17. This foolish policy is what causes the prevalent and serious lack of uniformity in departmental management. One superintendent or one foreman will manage his department along certain fair lines in wage systems and rates of pay, discharges, promotions, while alongside is another department, operated on a harsh, unjust basis on all these points which are so vital to a workman. Is it any wonder that there arises shop troubles?

18. It is as though in the American army each sub-officer were allowed to govern and train his men according to his own sweet will without regard to any general plan. One officer would be interested only in the use of the rifle, neglecting all else; another in bayonet practice; another in hand grenades; another in "getting by" with as big a show and doing as little as possible. One would be too harsh and unfair to his men, another too easy and slack. Each and all fighting and quarreling with one another.

19. Does any sane man think for one minute that our army could win when thus arrayed? Is it not equally asinine to think that an industrial battle can be won when the real governing force —the foremen—are fighting and jealous of one another; when each is governing and developing his department along different lines; one foreman loading his department up with his friends and relatives, giving them undeserved promotions, discharging the ones against whom he has a grudge regardless of ability, cutting rates of pay, getting the bitter ill will of his workers? Another foreman treating his people fairly, rewarding the efficient by increases in pay and promotions; training the poor workers to become more efficient; gaining their good will; getting out his work by proper management. Another foreman governing his force with a weak

hand, showing his workers that he is afraid of them; allowing the radicals to get the upper hand—*all of them* hesitating in any serious crisis because they have not been instructed in the company's policies?

20. A long practical shop experience coupled with many examinations of shops to ascertain causes of trouble, right "in the midst of it all," has proven to me that the lack of instruction and concentrated training of the *real governors* of your shops—the superintendents and foremen—in the firm's policies on vital shop matters, is the source of untold shop troubles and shop inefficiencies. The lack of training of these shop executives in modern methods of management by which shop problems are overcome and a shop brought to the highest efficiency in quantity production, quality of work, satisfying of labor is a serious matter.

The Good Foremen

21. Foremen, as a class, are a strong class of men. They have to be, for they have always fought their way up from the rank, and it is never an easy fight. They are always eager to learn, willing to fight to advance themselves. A first-class foreman is a regular "he man," and his job is a "he man's" job. No wishy washy mollycoddle ever succeeded as a foreman.

22. Of course, if the firm's officials are of the old type that believe in the bull-dozing exploiting of labor then the foremen will so govern their departments. The first-class foremen will soon drift away—the bull-dozing type remaining to put into practice these tactics which always lead to serious trouble. In this day and generation the old "high and mighty" arbitrary attitude toward labor had better be hidden away on the shelf. It will not work.

23. Now, I do not mean that any sickly, sentimental plan of handling workers will do, for any experienced shop man knows that strong control, firm discipline MUST BE MAINTAINED. Plans which slacken the reins of authority, which tend to weaken discipline will ever lead to failure. There are in any group of men a number of radicals who will seize upon any sign of slackened authority or weakness and take advantage of it for their own ends, and they have little difficulty in wheeling the conservative workers into line, if the methods used by the governing group of superintendents and foremen are oppressive. Once the radicals get the slightest degree of power, then trouble will follow. Having power without responsibility they will exercise it ruthlessly, for the con-

sequences of their actions, however bad, falls not on their shoulders. POWER WITHOUT RESPONSIBILITY NEVER HAS PRODUCED ANY BUT BAD RESULTS, and any system of management that contains such factors will ultimately fail.

Basis of Management

24. The basis of management, when it effects the worker, should be JUSTICE. The worker should be treated fairly on those phases of his shop life that are so important to him. The idea of "fairness" must in no way interfere with that authority which is necessary to get the best results.

The Worker's Attitude Toward Discharge

25. The worker feels that he should not be subject to arbitrary discharge if he is a good worker and has committed no breach of discipline. He should not be subject to some foremen's whim and grudge or unfair attitude. Men feel this question of unfair discharges keenly; some of the bitterest strikes in the history of industry have occurred because of this. The radicals amongst the workers use this as one of their strongest arguments in fomenting trouble. This situation must be met. The possibility of arbitrary unfair discharge of a worthy worker must be eliminated. It can be done easily as will be shown.

His Attitude Toward Cutting of Rates

26. He feels that if his wage rate is once set upon a job, he ought to be allowed to exercise his full skill, increase his output and earn more than the average pay without his wage rate being arbitrarily reduced by the foreman as soon as he exceeds an hourly rate that the foreman decides is proper for the job. He may study his job at home at night, work out some improvement, go at it the next day with vigor, increasing the output and earnings, and then find himself faced that night with a reduction in the rate. Trying it again with the result of another cut, and at the end of a week finding himself working 50% harder with prices so cut that he cannot earn more than when he started to speed up. This condition answers the question why workers limit output; why they loaf on jobs deliberately; why they always work for a large price on a new job; why they lack enthusiasm for the company's interest; why they are actually hostile. The truth is that the

worker will not take into account the important fact that in all prevailing rates, the rates originally set had been based upon an output so far below the normal that the prices were too high and so unfair to the *employer.*

The Employer's Side of the Rate Cutting Question

27. The employer's side of this question is that if workmen can increase their output 50% or more, they ought to do it and be satisfied with the prevailing rate of pay. He naturally resents their holding back an output he needs so badly. His trouble comes from the fact that his rates are not set by proper methods. "Guess-work" and "estimates" are the usual bases for estimating possible output and setting rates, and this always results in prices that are far too high with output too low. Many concerns under such conditions simply cannot afford to guarantee to their worker such rates against reduction regardless of the feelings of their workers and the statement of many writers who inveigh against cutting of rates of pay.

28. Perhaps if a few of these writers themselves were by strenuous exertions meeting a $200,000-a-year payroll on a certain production, and then discovered that their workers were loafing along giving them only half of the output they should—that the payroll that is so hard to raise ought to be $100,000 instead of $200,000—they themselves would speedily take a hand in cutting rates. This question cannot be disposed of by a few airy phrases about the iniquities of cutting rates.

The Proper Basis

29. From the standpoint of fairness to both employer and employee, the rates of output which determine the rates of pay must be calculated by a method that will give the employer the *output* that he has a *right to expect* from each machine and job, and will provide a basis for *rates of pay* that will be *fair to the average worker*—that will enable the extra capable worker to make large earnings, and which, above all, are so accurate that the employer can and will guarantee against any reductions.

The Big Problem

30. Owing to the widespread existence in American shops of too high rates of pay based upon outputs that are far too low with con-

sequent restriction of output owing to worker's fear of rate reduction—whether the shop is "open shop" or "union"—the questions that are the biggest, most important and most troublesome in all of shop management are first, how to *find out* what the best outputs are that the manufacturer should get from every machine—off of every job. Second, how can the workers' rate of output be brought up to these determined standards. Third, how is it possible to satisfy the operators with such demands for increase in output and the necessary adjustments in pay. These will be treated of later. At this point, I desire to emphasize the dissatisfaction of the worker with cutting of rates, but could not leave the subject without bringing out the employer's important side of this question.

He Resents Inequality in Wage Rates

31. He resents bitterly the inequality of wage rates in the different departments doing the same class of work—the fact that in his department the foreman holds the wage rate down while, perhaps in an adjoining department, a more fair-minded or easy-going foreman has raised his operators to a higher point. Also, that in many cases the rates of pay within a department are determined, not by quality and quantity of work, but by the feelings of the foreman, who has it in his power to reward his friends and punish his enemies.

Promotions Should Be Based on Merit

32. The workers feel that shop promotions should go to the man who has the best record. That if he is the best worker then the reward should be his. We must never forget that, while a small job-boss-ship may look like a small matter to us, yet to the worker it is one of the greatest importance for *it is his first step upward*. If he cannot make this first seemingly small step then he cannot advance from the ranks and future advancement is barred.

33. If, therefore, these small promotions should be handed out by a foreman to a relative or friend who may prove to be one of the inefficient workers, as they often are, the result is destructive. The best worker feels that he is justly entitled to this all-important advancement, and proper ambition fires his hopes of securing it. This wrong method not only destroys the worker's interest and ambition—makes him feel that efforts to rise are useless, makes him resentful—but it also leads to the promotion of the inefficient to important positions which ultimately produce serious results.

The Big Problems

34. The big shop problems are locked up in these few propositions. They are important because they are the ones that vitally affect the every-day existence of the worker, his earnings, his retaining of a good job if worthy, his chances of promotion.

The Common Sense of It All

35. Aside from the question of justice, it is common sense to solve these problems properly, for, aside from their effect in increasing production, is the important result of keeping down shop troubles.

The American Workman

36. The American working man may be broadly divided into three groups:

First. The radicals who believe nothing good of any manufacturer—who are destructive in their tendency, and who are always trying to stir up strife.

Second. The semi-radicals who feel bitterly toward the manufacturer and who yet are not willing to go as far as the radicals.

Third. The conservative group which comprises the big body of American workers, who ask only for a fair deal.

37. The radical group are everlastingly on the job causing trouble. They live on it. They are the ones who always attend the union meetings in full force (the conservative group usually staying home), and who pass the motions for radical actions which bind the conservative members as soundly as it does them. They are the ones that begin their troublesome activities in the shop whether "union" or "open shop," and take full advantage of every mistake the management makes in their dealing with labor.

Throwing the Conservatives Over to the Radicals

38. When the manufacturer permits the continuance of such shop methods as embitters and renders hostile the conservative workers he is simply throwing them into the arms and under the control of these radicals. He not only supplies the fuel, but even starts the blaze and helps fan the flames which these radical trouble makers utilize to destroy him. Remove every method of your

management that will give the workers a just cause for discontent and distrust.

REMEDIES

39. THE ONE BIG OUTSTANDING REMEDY FOR SHOP TROUBLES IS THE DEVELOPMENT OF THE FOREMEN THROUGH INSTRUCTION AND TRAINING SO THAT THEY WILL TRULY CARRY OUT THE MANAGEMENT'S AIM IN GOVERNING THEIR DEPARTMENTS AND WILL APPLY DIRECTLY TO THEIR WORK THOSE MODERN IDEAS WHICH WILL LEAD TO SATISFIED LABOR, INCREASED PRODUCTION, REDUCED COSTS.

THE FIRST STEP

40. The management itself must, after careful deliberation, settle upon definite policies on vital shop problems which must be carried out and which they will stick to "through thick and thin."

THE SECOND STEP

41. The officials must themselves confer with the managers, superintendents, foremen and job-bosses and instruct them all thoroughly in these determined-upon methods. They must not tolerate any deviations therefrom. Then unified action will be secured.

42. It seems incredible that in any shop the governing force of superintendent and foremen should be compelled to guide their departments, and each determine their own method of management. their own policies, on vital points without knowing what the real policy of the company's officials are on these questions, how they wish them handled, what they will and will not stand for. Yet it's a fact—as singular as it is true—that in not one case in ten do the officials of a company attempt by speech or writing to advise these men how they *must handle* these shop questions so vitally important to them and the workers; what their own plans are; what they will give their support to without wavering.

THE THIRD STEP

43. They must watch the situation carefully to see that their instructions are actually being carried out. Unless this is done, the foremen will invariably interpret the orders according to their own standards and habits and there will still develop methods in

different departments that lack uniformity, and that will cause trouble sooner or later.

DEFINITE POLICIES TO SETTLE

First—Cutting Rates

44. Shall workmen's rates of pay, such as piece work, bonus or premium, be reduced arbitrarily when the worker so increases his output as to earn more than the factory management (the foreman and the superintendent) think is a fair wage? Or shall the rates be guaranteed against such reductions and the workers permitted to earn as much as they can?

Second—Day-Work Rates of Pay

45. Shall the day-work rates of pay to workmen (tool makers, inspectors and operators), tool designers, stores, be regulated according to the recommendations of the foremen and superintendent, or shall they be regulated upon a fair system of graded increases according to length of service and skill combined.

Third—Labor Turnover

46. Shall there be a regulated method by which workmen once employed shall be retained in the service—either trained to become better workers on the jobs they are on now, or transferred to other jobs more suited to their capabilities? Or shall the question of labor turnover be disregarded and operators allowed to come and go with no systematic effort made to hold them and so reduce the tremendous losses arising from heavy turnover?

Fourth—Employment

47. What is the employment policy? The extent of the authority of the employment department? Shall it alone employ, or shall the foremen have any hand in it? What is the policy in regard to employing relatives of heads of departments?

Fifth—Discharge

48. What is company's policy on the important question of discharge? Shall a worker be protected against arbitrary discharge provided his record for output is high and discipline good—or

shall the foreman have the right to discharge an operator if he so chooses, without appeal? If some plan of appeal is evolved, will it interfere with that degree of authority so necessary to the foreman if he is to run his department properly? Shall the employment man or a committee have the right of final adjudication of discharges?

Sixth—Promotions

49. Is the company's present method of promotion under control? Do the best, the most efficient men come from the bottom up to the top? Or is there a chance for favoritism to friends or relatives to play a part? Can any of your workmen feel, that if his work and output is superior, he will stand a sure chance for promotion? Or does he find that shop favoritism to friends or relatives prevent him from getting higher even though his record may be the best?

Seventh—Detecting the Inefficient and the Efficient

50. Shall the company have a simple system of detecting the inefficient worker—the one who fails to get the proper output off his job so that he may be trained to become better or be displaced—or is it the policy to leave this important task up to the foremen already overloaded with work and who will probably let the force he has get along the best they can, be they efficient or inefficient.

Eighth—Training

51. Shall any regulated method be evolved of training the American mechanic who, as a general rule, is unskilled except on a few jobs, so that they may quickly get up to a standard production? Or shall the usual system of dumping the inexperienced worker (who *claims* to be a mechanic, but is not) on to his job to "sink" or "swim" *at the expense of the company,* be adhered to?

Ninth—Wage System

52. Aside from the question of cutting of rates, standardizing rates, etc., comes up the question of a proper wage system to use. Shall it be the day-work system, or piece work, or bonus, or premium? What plan is the best for stimulating the worker to give a full day's work? What is fairest to employee and employer?

53. These all are live shop problems that every superintendent

and every foreman has to meet, and it is, therefore, of prime importance that the company officials settle their policies in regard to these and then fully instruct their head men how to follow them out.

54. Personally, I have always found it wise to discuss these questions with a group of the best superintendents and foremen before coming to any conclusions so that we might understand their shop problems and the effect upon them of any decision we might make. Then we went at this matter with our eyes open.

A DISCUSSION OF THE NINE POINTS

Arbitrary Cutting of Rates

55. Any sensible man will admit that, if the workman's prices and rates are *set fairly*—if they truly represent an output that ought to be gotten out by the average skilled worker from any job—then it is wrong, it is foolish, to reduce the rates when any one of a group of workers through study or acquired skill increases his output and earnings above the average. The moment this is done then the workmen put the clamps on production and limit the output to that point where their earnings will not exceed the amounts they think the foreman will stand for.

The Gain in Overhead Costs That Comes Through Increased Production

56. We manufacturers must keep in mind the gain made in overhead costs, which represent the same kind of dollars as labor costs, when an output is increased by the same operators with the same machines, tools, floor space. Let us assume that a certain part costs 20c.—that 25 per day is the output—overhead 150% on direct labor = 30c. per part, or $7.50 allowance for overhead on the day's output. Assuming that as usual the output can be increased 60% and the workman reaches 40 per day, earning $8, then the overhead against this 40 per day would be practically the same $7.50 or 18½c. per part a gain of 11½c. per part. This shows the substantial cost reduction in overhead per part that results from an increase in production alone.

57. Of course, the overhead charges would be slightly increased above $7.50 by the consumption of more small tools, increased power, greater maintenance charges, etc., but this may be disregarded as they are only small factors compared to the big items of overhead.

58. This cutting of rates is the cause of more shop discontent and distrust on the part of the worker than any other practice in factory management; and yet, the hard-headed practical factory man knows that it cannot be avoided in the vast majority of shops owing to the fact that the rates on the job are evidently too high. The original estimate of output upon which the prices were based were calculated much too low.

59. As stated previously, the worst practice that is general is the basing of outputs, and hence rates of pay upon output results arising under an old day-work system of pay. The day-work system, without supervision of quantity of output, is such a breeder of inefficiency and low output that such outputs *cannot* be used as a basis of judgment. Again, too, the next worst instance is the plan of having the foreman sets rates for he, nine times out of ten, does this by guess-work and this leads to gross errors.

60. The average management therefore has this serious handicap to struggle under. The pay rates (piece work, premium or bonus) are too high—the calculated output too low—the workmen keep down the output so as not to disclose these high prices, and when a high price is discovered and cut the workmen grow sullen and discontented.

61. It is all very well for the theorist to say "guarantee the prices and let the workers cut loose and make as much as they can," but what would the theorist do if he found that in his business there were 361 jobs that were over 200% too high, as I told of in previous chapters—that his men should be easily producing from 60% to 80% more than they are without excessive effort. When he thought of the tens of thousands of dollars that he had collected with much grief and trouble and that he had paid out to "a lot of loafers," he would "cut those rates" and have his money even though he violated his fine spun theories.

62. The hard-headed factory superintendent knows that under such conditions he does not dare guarantee prices against reductions. The earnings on different jobs would differ, some would be excessive, some not, thereby breeding discontent.

63. The worst feature of recklessly guaranteeing of pay rates (piece work, premium or bonus) that are too high is that this would fasten permanently upon the company a cost of product that would be entirely too high—would cripple them when against competition, and would lead to a too high selling price.

64. The whole question then boils down to the following:

1st. Wage price (piece work, premium or bonus) must be

guaranteed and a workman allowed to get out all he can or earn all he can.

2d. Wage prices *cannot* be guaranteed in the numberless cases where these prices are too high.

3d. A method must be developed that will show clearly what the output and wage prices should be so that the manufacturer can guarantee them.

4th. A method must be evolved whereby such proper outputs and prices may be put into effect in the shop without causing labor strife and difficulties.

Equalizing Rates of Pay for Equal Service

65. In every shop which I have investigated I have found inequality of pay for equal service, in those shops wherein a day work hourly rate of pay is the basis of the wage system such as day work itself, or one of the premium or bonus systems. This also applies to tool room, inspection, stores, etc. The rates of pay for the different jobs may be well set for the *starting* rates, but the *later advances* in hourly rates are usually bady mismanaged, there being no standard method of increasing pay based upon efficient service and length of service. The good, conscientious foreman, knowing the desire of the superintendent and the management to keep down labor cost and fearing criticism, fears to send in raises in pay that are really deserved and should be granted, thus causing a feeling of resentment amongst his best men. The bad foreman, knowing that raises will probably be few and far between sees that, if any raises go through, they are given to his relatives and friends, this giving rise to an especially bitter feeling on the part of the other men. Another foreman, who may have more influence than the others, may gradually establish rates of pay throughout his department that are materially higher than those in an adjoining department doing work requiring equal skill. Such conditions arouse intense dissatisfaction.

To Handle This Situation Properly Adopt the Following Procedure

66. First Step. Classify all jobs according to the grade of skill required, putting jobs requiring approximately the same skill in the same classifications.

67. SECOND STEP. Have payroll department list up names of workers in each group giving also length of service and wage rate.

68. THIRD STEP. Establish for equal groups a fair starting rate —then establish such increases as are considered proper together with the time that must elapse before each rate may become due. Then, a final rate for the skilled worker who has been with the company the required time. The rates, which can be called the "standard increases," will be determined by the character of the work, the cost of living, the rates prevailing in the neighborhood.

69. It is to be understood that any worker, after being with the company for any of the specified periods, is entitled to the standard increase, *provided* only that *his or her skill justifies it.*

INCREASE OF RATE RECORD NAT'L MFG. CO. DATE..........
NAME.......... CHECK NO.......... DEPT..........
DATE EMPLOYED.......... CLASS OF WORK..........

DAY RATE INCREASES.			REPORTS ON EFFICIENCY	APPROVED BY	IF DISAPPROVED WHY?
CLASS	RATE AMOUNT	DATE DUE			
STARTING					
1ST INCREASE TO					
2ND " "					
3RD " "					
FINAL RATE					

FIGURE 60.—Form for Record Increase of Rate, Refer to Paragraph 71

70. FOURTH STEP. The system can be easily handled by a card system which provides that for each week there will come up for attention all the names of operators that may be entitled to an increase on that week, *provided* their average output and skill justifies it.

In column No. 1, Figure 60, are placed the starting rates and standard raises.

In column No. 2 are placed the dates when raises become due.

In columns Nos. 3 and 4—these columns signifying approval of the raise on the basis of output and efficiency. Where individual efficiency cards showing the output and efficiency of each operator

is used, then this is secured from these cards. The O.K. of the foreman is, however, necessary.

When efficiency cards are not used, then the output and efficiency of the operator is determined by conferring with the Foreman, who either approves or disapproves of the increase.

Column No. 5 shows why raises are *not* given the operator on due date. This information is to be gotten from efficiency cards and foreman. The operators in such cases, must be given to understand why the raise is not forthcoming and be told that unless improvement is shown they will be discharged—unless transfer to other work is feasible and advisable. This method provides an excellent and simple method of regularly locating the inefficient operators. They cannot escape.

72. When transfers to other jobs are made the operator transferred starts at the starting rate, no matter how old an employee he may be. Unless this is done, the old operator on this new job becomes much dissatisfied.

Third—Labor Turnover

73. The governing group must be given to understand that the company does not propose to tolerate the big labor turnover of 60, 75 and 100% that is so common. That each man will be held accountable for the turnover in his department and that it is one of the big factors in determining a foreman's efficiency.

74. If their trouble lies with the class of labor employed, then reports are to be made so that it can be taken up with the employment department to see if any improvement can be made. If the class of labor *cannot* be improved, then the foremen must do the best they can with the labor sent them. We must not forget that a foreman finds it very easy to discharge a lot of people sent up from the employment department as being inefficient and then blame shortage of output on the employment department.

75. If you are satisfied that the employment department is getting the best class of labor for the different jobs that is possible, then the *foremen must make good with what they get.* It is, therefore, their business to see that these people are trained for their work and kept on the job. Big labor turnover is always a sign of deep-seated inefficiency and you can always be certain that this means that your costs are far higher than they should be.

Fourth—Employment

76. Personally, I have always found it wise to let the employ-

ment department do all of the employing without assistance or interference from the foremen. I have, however, *always been careful* to have a first-class mechanic as the man to employ mechanics. The average American "mechanic" is a sad specimen of an all-round mechanic. He has, for instance, learned how to run a lathe on a few jobs in a few shops. He is then an "experienced lathe hand worthy of the highest wage" to hear him tell it. Or, he has been a helper in a tool room; at his next job he is transferred into a "tool maker," and so it goes.

77. As a matter of fact, the average American mechanic knows enough to become a good specialist on a job *after* he is trained on best methods of doing it. Left to himself, as he usually is, he simply pesters his fellow-workers beside him until they show him how the work is to be done. Learning all *their* bad habits, plus a few that he picks up "on his own hook," the average worker slowly and laboriously increases his output to a point where he is safe. But while he is learning, the efficiency of his machine tool and those of his teachers are being reduced.

78. It, therefore, becomes important that the selection of men for different jobs be made by a man who is a mechanic who, by handling the various blue prints, small tools and gages and requiring explanations, can soon tell where they belong. Such a plan will cut out much of the antagonism and contempt that the factory feels for the average employment department which arises largely because of this department's lack of knowledge of their real needs.

79. I do not favor having foremen interview applicants. It takes too much of their time and gives too much chance for the introduction of friends and relatives. The only excuse for this can be is that the employment department does not know enough about the foremen's needs. Foremen are too busy men for this work. If employees sent in are unsatisfactory, then the foremen should appeal to the superintendent who can take up and remedy the situation.

80. There should be one rule that is absolute. No foreman should ever have a relative employed in his own department. When possible, this restriction should also apply to his friends. A foreman is only human. It is human to promote your friends and relatives, but it is fatal to efficiency.

Discharge

81. Some concerns, recognizing the dangers that lie in un-

controlled discharges at the whim of an arbitrary foreman, have gone so far as to take away from the foremen the right of discharge, placing it in the hands of an employment manager, or making it subject to review by a committee. Knowing so well the difficulties that face a foreman running a department, large or small, I know that he must RULE or his people will RULE him. Take away from him his powers to discipline them, to discharge the incompetent and the unruly, and you have palsied his hand.

82. The working man and woman are far from being agreeable angels. Having but little regard for the firm they work for they will take advantage of every situation they can. If the foreman finds that the company deliberately strips him of his necessary powers he, being only human, is very liable to let things drift along in his department as they will, with the result of it ultimately finding a dead level of inefficiency.

83. A long experience in actual factory management has taught me that the *foreman must rule his department* subject only to his superintendent, but must do so under restraints that while they do not diminish his authority when exercised properly, still will prevent him from acting arbitrarily or unjustly.

84. The best method of controlling this is through the individual efficiency card. In Chapter III, pages 80 and 104, I have explained how simple it is to get the weekly output of each operator off his time tickets, at the same time these are being extended to ascertain his earnings for pay roll. Then how his average hourly output is entered upon his individual efficiency card which card also contains the actual standard hourly output which represents the output determined by actual tests that his concern has a right to expect off his job, these cards to be kept in the factory department responsible for this figuring such as factory systems or pay roll.

85. I here show how the operator's efficiency or inefficiency can be determined, week by week, by comparing.

(*a*) Standard hourly output for jobs, and

(*b*) Operators actual hourly outputs off of job, as shown on his particular card.

86. At the bottom of this card are several lines upon which will be placed any minor complaints made against the operator from time to time.

How These Cards Operate

87. When the foreman determines to discharge an operator

he fills out a discharge slip which may be of a form similar to Figure 61.

88. I favor particularizing the reason "inefficient and insubordination," "other reasons," so as to force the foreman to "think" before he acts. The question as to the foreman's opinion of the operator's efficiency is another check. The foreman, knowing that the operator's actual efficiency will be placed on the card by the factory system or other department handling these records, will feel obliged to put down his honest opinion of the

DISCHARGE SLIP **NAT'L MFG.CO.** DATE...............

DEPARTMENT.............THE FOLLOWING OPERATOR IS DISCHARGED
NAME......................CHECK NO.............. JOB..................

(a) INEFFICIENCY(GIVE DETAILS)......................
DISCHARGED FOR..
(b) BREACH OF DISCIPLINE(GIVE DETAILS)..............
....
(c) OTHER CAUSE(GIVE DETAILS)...........................
....

SIGNED ....
FOREMAN

EFFICIENCY RECORD REPORT. WHAT IS STANDARD HOURLY OUTPUT ON JOB......
REPORT OPERATOR'S AV'GE H'RLY OUTPUT RECORD FOR PAST 60 DAYS..........
HOW LONG EMPLOYED..........WHAT OTHER COMPLAINTS..................
SIGNED..
FACTORY SYSTEMS

TO FACTORY MANAGER-IN VIEW OF ABOVE RECORD YOU WILL DECIDE IF DISCHARGE SHALL GO THROUGH.

APPROVED..
FACTORY MGR.
NOT APPROVED....................................
FACTORY MGR

NOTE HERE FINAL ACTION
....

FIGURE 61.—Form for Discharge Slip, Refer to Paragraph 87

operator's skill. If he has acted hastily in discharging a good worker, the recording on this slip *by himself* of the worker's good record always brings him up with a jerk and acts as a stop against hasty action. He knows that his reasons for discharging a first-class operator have to be good and strong, or they will be subject to review.

89. The discharge slips, when made out by a foreman, are not effective until they have passed through the factory systems or other department having control of the operator's records. This department, when it receives a discharge slip, pulls out the operator's

card and places on the slip the operator's record of output and any registered complaints showing clearly whether or not this operator is a first-class desirable worker. If undesirable, the slip is marked as passed. If desirable, the slip is marked as passed to the superintendent or factory manager for review.

90. The slip containing such data is then sent to the factory manager or superintendent. If he notes that the operator is a first-class man or woman then the foreman should be called in to give a full report. Such a case upon review may present features that force the withdrawal of the discharge for it must be a principle that a first-class operator must *never be discharged without very good reasons.* If approved, the discharge slips go to payroll department.

91. This question of control of discharge presents many difficult features, the chief one being that it is usually fatal to discipline and control to place a discharged operator back into a foreman's department. In my experience I found that, after this plan was explained to the foremen, they looked up the efficiency records of the employees *before* discharging them, and devised ways of disciplining the good workers when it becomes necessary without discharging them. Knowing that a discharge would be subject to review made them very careful to be just and to have good cause before acting. When a discharge is made for good and sufficient reasons then *it must stand* and no sentiment for friends or relatives allowed to enter as a factor.

92. It will thus be seen that the foreman is not hampered in his necessary authority. He is not humiliated by being compelled to defend his actions in discharging an incompetent worthless employee who can often present the most plausible case if there is no record against him. Nothing is more destructive of discipline and efficiency in a shop than to take back a good-for-nothing employee over the foreman's head. It is almost as harmful to transfer them to another department. There is always a certain element in every group that takes great delight in "putting one over" on the foreman, and if the management has overruled him in this particular, they not only plague him in many sly ways many times a day, but also undermine his authority.

When the Company Keeps No Efficiency Records

93. When the company keeps no individual efficiency records either because they have never tried or do not wish to undertake it

—easy and low of cost though it is—there can still be exercised a beneficial degree of control.

94. First Step. Have the management explain to the factory governing force (superintendent and foremen) the precise company policy in regard to discharge; that the company desires and intends to *retain* its efficient workers; that it wants the bad workers or "bad actors" gotten rid of and that it expects the foremen's help in this. That no good worker is to be discharged except on very

DISCHARGE SLIP **NATIONAL MANUFACTURING CO.** DATE..........
DEPARTMENT............ I DISCHARGE THE FOLLOWING OPERATOR
NAME.................. CHECK NO............. JOB..................
(a) INEFFICIENCY (GIVE DETAILS)................................
DISCHARGED FOR (b) BREACH OF DISCIPLINE (GIVE DETAILS)................
(c) OTHER CAUSES (GIVE DETAILS)................................
WHAT IS YOUR OPINION OF OPERATOR'S EFFICIENCY?....................
WHAT ARE AVERAGE HRLY. EARNINGS?....... LENGTH OF SERVICE..........
Signed.......................... Foreman
Approved........................ Superintendent.

Figure 62.—Form for a Slip for the "Proposed Discharge," Refer to Paragraph 95

good grounds—that labor turnover is to be reduced to a minimum and employees retained and trained instead of indiscriminately discharged. This gives the foundation. It should be gone over again and again until the foremen cannot mistake it.

Second Step

95. When any foreman proposes to discharge an employee, let him fill out a slip similar to Figure 62.

96. By the time the foreman fills out such a slip himself, showing "length of service" and "opinion of operator's efficiency," he will hesitate to send it through should it refer to a worker who has been with the company for some length of time and who is a good worker, unless he has good cause. A wise superintendent who gives his personal attention to these slips and who is in accord with the company's policy will control the situation nicely. His knowledge of the peculiarities of his foremen will enable him to size up a dis-

charge situation quickly and his estimates of the justice or injustice of it will usually be correct. If he disapproves then his conference with the foreman will settle matters. If he approves, the slip goes through to payroll department.

97. These methods give the management a real *control* of the situation and will put a stop to the big labor turnover which is so prevalent and so costly.

Promotions

98. We must never forget how important to the workman is that first step upward to the little job-boss-ship that is directly above him which appears so unimportant to the management. He knows that if he cannot negotiate that first little step he can never advance to the foremanship or superintendency. Therefore, the little job *looms big* in the worker's mind.

99. Can he capture it when a vacancy occurs if he is the best man on the job? He hears the officers orate over the beauties of promotion. He reads much of how he will be rewarded should he but show his merit; only to come to work some morning to find the coveted job, which should be his, turned over to some friend or relative of the powers that be, said individual usually being inefficient.

100. This common shop practice not only kills the ambition and interest of the workers but also results in inefficient incapable men being raised to positions of authority. It is therefore important that positive steps be taken to see that PROMOTION GOES TO THOSE WHO DESERVE IT.

101. When the individual efficiency records are used, the procedure is simple.

First Step. When an opening for a job-boss-ship occurs, the foreman is to notify the superintendent. Together they get the individual efficiency cards of all operators in the group affected and going over them select the most efficient for the job.

102. Second Step. The operators are notified of the selection together with the reasons why, care being taken to show that this action is based upon the showing of their individual efficiencies on these cards. This always impresses them strongly with the fact that the company knows what they are doing and that "the best man wins." I have found it wise to display their cards to them at such times.

In Case the Company Keeps No Efficiency Records

103. If the company keeps no individual efficiency records, it becomes necessary to care for this important situation in as effective a manner as possible under the condition.

104. First Step. Before any appointment is made, have the foreman fill out a slip (typewritten), somewhat as Figure 63.

RECOMMENDATIONS FOR PROMOTIONS **NATIONAL MANUFACTURING CO** Date............

The Following Position is Open..

..................................This Pays as Follows: ....

....

Number of Workers on Job...............................

Operator Longest on Job-Name ....Length of Service ....

Operator Earning Highest Pay-Name..................Amt. .... Length of Service ....

Operator Earning Lowest Pay-Name...................Amt. .... Length of Service ....

I Recommend ....

Do you Consider him the best Man on the Job?...

Why?...

Is Operator a Relative of Yours?...

Signed .... Foreman

Approved .... Superintendent

Figure 63.—Form for Recommendation for Promotion, Refer to Paragraph 104

105. I have found such a form effective. The foreman knows the company's policy to promote only the most efficient. In filling out this form he must give first the length of service of the one recommended for promotion as compared with the one who has been longest on the job. He must give his opinion of his record as an efficient man, and must state whether or not he is the best man on the job. By the time he has filled out these questions, he has had time to think. Nine times out of ten he will make the proper recommendations. The superintendent's review of each case and the questions asked will strengthen the situation. These slips should be filed away carefully in the superintendent's office for future reference.

106. The promotion method that can be used effectively in the case of advancing to Foremanship or beyond will be considered later

CHAPTER XVIII

ORGANIZATION

DEVELOPING THE GOVERNING GROUP OF SUPERINTENDENTS AND FOREMEN

Getting Co-operation—Developing the Best Men—Solving the Shop Problems—Increasing Production and Reducing Costs

1. ANY half-way man can have buildings erected, machine tools installed, engines started, everything moving. But those brick walls and that machinery are NO GOOD WITHOUT MEN; and whether those tools turn out your work fast enough, accurately enough, and at a low enough cost for you to make a profit, depends directly upon the way you handle and develop your *organization* and the way your organization handles *its* problems.

2. A fine organization of men—driving each of their departments forward to success, driving together in harmony and full of the spirit of co-operation—is the greatest asset any firm can have. The finest equipment in the world manned and operated by a jangling, quarreling organization will be whipped any time by an old shop full of out-of-date equipment, but also full of bright men who pull together, whose one thought is the success of their departments and the business.

3. We now come to a consideration of the governing group—the superintendents and the foremen.

THE FOUR ESSENTIALS

4. There are four essentials to any plan of organization.

FIRST. The development of the spirit of co-operation amongst the heads—their willingness to work for their own department and help the other man in order to drive the company on toward success.

SECOND. The management must devise a method that will

bring out the invaluable knowledge and ideas of these men that usually remains locked up within their minds—ideas and thoughts that would solve many a problem, save many a thousand of dollars.

THIRD. The education of these heads in the latest and best methods of management, the best methods of increasing production, lowering costs and keeping labor satisfied.

FOURTH. The development of a system that will bring out the best man from the ranks—make them *stand out* so that they *must* be noticed—and then develop them to become efficient members of the governing group. Arrange your methods so that "you can't keep the good man down."

Jealousy and Envy Destroys Co-operation

5. There can be no question but that in most concerns there is, as any superintendent can tell you, an almost unbelievable amount of jealousy, envy, a tendency to back-bite and blame the other fellow that destroys all spirit of co-operation and that keeps the production down and costs up.

Lack of Suggestions and Ideas

6. The worst of this situation is that these men who are in daily contact with the shop problems, small and large, that involve all of production, seldom come forward with their thoughts and suggestions. I have never failed to find that these men's minds were perfect mines of information—suggestions—knowledge that would have proved invaluable to the company.

Lack of Study and Training in Latest Methods

7. Again, too, the foremen, disgruntled and often sullen, seldom try to improve themselves. They get into a rut and refuse to look out of it or wear it so deep that they can't get out of it. They go along every day in their old way never knowing that improvements in machines and methods are being made that would help amazingly to make their departments bigger and better producers. Whether or not they realize the fact, they need to be shown and taught these latest money-making ideas so that they can adapt them to their own work.

The Efficient Are Not Promoted

8. The waste of good human talent, of fine latent ability in the

average shop, is almost shameful. There are hundreds of workmen and job bosses hidden down amongst the shop processes that would make the finest kind of foremen and develop into capable superintendents. But they are submerged. They can find no way to stick their heads above the common ruck and attract attention.

9. It is always so difficult to get good foremen that every method to train up good job bosses into finer foremen is the best kind of common sense. Yet the method of promotion is usually so defective that there is at least an equal chance that the men promoted from the ranks will be inefficient as I have already explained.

The Problems of Effective and Efficient Organization

10. (*a*) The inculcating of a true spirit of co-operation, of help one another, of team work amongst the superintendent and foremen.

(*b*) With this must be developed methods that will persuade these men to unload their minds—to give to the company the ideas and suggestions that they have for the benefit of all.

(*c*) The company must provide these men with every facility for reading, hearing and learning the latest methods of production. The great advances made during the war should not be sealed to them. The valuable magazines, trade papers, and books now published contain every month material that is of use in their shop practice. Form a simple library containing all these, put it into the shop, let them help themselves freely and watch them grow.

(*d*) The importance of promoting the efficient men and the efficient only, can hardly be exaggerated. Any firm that is growing must be dependent for its efficiency upon the influx of new blood. If the newcomers are your efficient men then all is simple and success is certain. If they are inefficient, then endless trouble, low production, high costs will arise. We must never forget that in a complex organization only one bad department, only one weak link, can ruin the chain of factory production.

11. The superintendent and foremen are always a forceful set of men. They have to be or they could never have fought their way up from the bottom. All they ever need to advance to a position where they could prove of the greatest assistance is THE CHANCE. They have their troubles—troubles by the hundreds, and of a character that would make a weak-spirited man give up. Generally, like all strong men, they are strong willed and hard to

change, but once given the chance you can see them grow by leaps and bounds.

12. When once you get them to working together, when once they learn that their fellow-foreman is a good fellow after all, and find out the advantage to themselves and the company that arises from *real* team work, you then have a lot of "co-operators" that nothing can stop. This all has been accomplished so often with a group of foremen that had formerly been fighting and back-biting, passing the buck, getting the other fellow in bad—that I *know* that any such problems can be solved if gone at right. A few general rules must be followed out strictly.

13. *A*. The management and superintendent must guide all their actions with the foremen by fairness and justice. There must not be allowed to enter the slightest sign of favoritism either through friendship or relationship.

14. *B*. There must be a distinct division of authority, supervision and duties. Each department head must understand the full extent of his authority and duties, and all others must understand that they are not to encroach on them. Nothing will break down the efficiency of an organization quicker than an over-lapping and conflict of authority.

15. *C*. In the issuance of orders there must be an unbreakable rule of procedure from each head down. Under no circumstances should a superior step over the head of one of his subordinates. If this ever becomes necessary, then it is time to get a new subordinate.

16. *D*. Every man must get full credit for his ideas and suggestions, each one being encouraged to give the company the benefit of their best thought.

17. *E*. Every man must get clear and explicit instructions covering the company's policy in the handling of labor, control of discharges, promotions, cutting or guaranteeing of rates of pay, management of their departments. This is most important.

18. *F*. Some method must be devised whereby the superintendent and foremen may be brought together into close contact. They must be shown that their problems are affected by the troubles of their fellow foremen; that the other man is not such a bad fellow after all; that pulling together will help them and the company far more than pulling apart and fighting one another.

19. The consideration of each other's work as well as their own will prove an excellent educational force—will make each man bigger and more fit to hold higher positions. The general spread

of important information amongst the foremen prevents the serious trouble that arises where some man leaves with important information "under his hat" and no where else.

20. The best plan yet devised for building up a spirit of co-operation—substituting team work for that harmful spirit, "Every man for himself, the devil take the hindmost"—for educating your foremen to be bigger men—for getting from them their best thoughts and suggestions—is the formation of your superintendents and foremen into standing committees. Of course, there are relics of an old age who favor the iron rule of arbitrary authority and who do not look with favor on any system that will bring out, upstanding in the light, the good men under them, and incidentally show up their own weaknesses. Men of this type are opposed to committees.

21. However, the principles of the committee system are fundamentally correct and will always bring a full measure of success when worked out properly.

The Committees

22. At the outset it must be understood that these committees in no wise diminish the authority of those at the head such as the factory manager or superintendent. In a factory organization there must be a distinct line of authority established from officials to factory manager, to superintendent, to foremen, to job bosses, and no methods can be allowed to interfere with this. For instance, the authority of a superintendent over his division must be supreme and subject to no man's control excepting his superior, the factory manager.

23. The underlying idea of the committee is that each *must be of an advisory character only*. The problems that each man has to meet are laid before the committee for full and frank discussion, but the *final decision* will rest with the superintendent who will be chairman.

24. It is advisable to keep the committees as few in number as is feasible, keeping in mind, however, that there must be enough of them to bring in the important foremen so that the education and get-together spirit may be instilled into them.

25. The committee should not number over five to seven—preferably five. Meetings must be held *strictly* to schedule. Every man must so arrange his work as to be at the meeting on time. Meetings must be short and snappy. The long-winded brethren must be cut short. A lively stenographer, acting as secretary, can

arrange the program. A meeting of 20 minutes in length is usually long enough. Teach your men to state their troubles briefly—each man to explain his failures in as few words as possible. They will soon learn to be brief.

26. *Above all, settle every trouble* that's humanly possible *at each* meeting; give final instructions to the stenographer; have him get out the notes and orders *directly* after the meeting and into the hands of the superintendent and foremen *at once.* Then have the stenographer with a good follow-up system start after the men to whom orders have been issued and keep after them everlastingly until *every order is carried out*—every trouble overcome. Allow *nothing*—not even the smallest item—to go overlooked. This crowding of matters, the quick settlement of difficulties, have a splendid effect on the foremen for they grow enthusiastic over this committee work when it *accomplishes things* and *helps them.* On the other hand nothing will kill a committee's work more effectually than long winded, tiresome meetings at which nothing is done in a definite manner.

Program

27. A definite program should be laid out and followed so that the members of the committee may know what matters to bring up, what reports to make. The secretary lays before the superintendent all matters not attended to and all special reports required.

Sample Program

28. Meeting after luncheon hour.

Production Committee—of factory manager, chairman, and superintendents of machining, assembling, inspection, factory systems and stock tracing, engineering and tool room.

1st. Production conditions for the day—where any hold-up, be it shortage of materials or tools, or operators or excessive scrap, etc. Discuss with superintendents whose departments are involved; devise remedies, issue orders, force prompt action.

2d. Report on all work ordered but unfinished—superintendent responsible to report.

3d. Consider production report for previous day. Where any delays or "fall-downs," and why. Discuss with superintendents of departments involved. Devise ways to overcome troubles—issue orders.

The General Meeting

29. During the mornings these superintendents have been learning from their committees and their various departments the reason for any difficulty. They have through their association in committees learned the advantage of helping one another. They soon learn the advantage of settling as many of their problems as possible before coming to the committee meetings for the one at fault knows that he will have to do some real explaining of any difficulties not overcome. As a result the committee meeting will deal only with live pressing problems.

30. In this manner every trouble, big and little, is caught and attended to at once. This method means *real control.*

31. THE ONE BIG MOTTO MUST BE "CONSTRUCTIVE SUGGESTIONS NOT DESTRUCTIVE CRITICISM."

32. Once a week there should be a special meeting held, preferably in the evening, of the production committee, with some of the more important foremen and the heads of stores, of stock tracing, and of costs. At this meeting should be considered the big broad questions of developing efficiency in departments, increasing production by various means through determination of standard hourly outputs, training of operators to reach these standards, methods of pay, what items are costing most, how to reduce these costs, improved tooling needed, advantage of new types of machine tools, consideration of those parts giving most trouble either because of delays or difficulties of manufacture, causing high costs.

33. Such meetings are invaluable. Every man will want to make a showing, to make some suggestion, to show his ability to help. Put your production problems before a meeting of this kind and you will be continuously astonished at the excellent results.

34. Once a month the production committee should go over the efficiency records of the job bosses so that the best of them may be singled out for promotion when the opening comes.

35. The various committees I suggest are as follows:

Main Committees

(1) Production committee—factory manager, chairman—superintendents of machining, assembling, inspection, factory system (which controls stores, costs and stock tracing) and engineering (which controls tool designing and tool room).

Meeting after lunch every day.

Program as shown.

SUBSIDIARY COMMITTEES

(2) Superintendent of machining, chairman, with 4 foremen of most important departments. A representative of the stock tracing department should be present.

A typical program.

(*a*) Consideration of the day's difficulties—where each one is being held up; what can help. If in any of the superintendent's department, then order to have difficulty cleared up. If in some department not under this superintendent's supervision, then he is to make note of it to take up with proper superintendent. If not attended to at once, then he is to report to the production committee.

(*b*) Consideration of the conditions of parts on rush list.

(*c*) Consideration of any items that are hanging over unattended to from previous days and ascertaining why they are not cleared up.

(*d*) Departmental affairs causing difficulty such as defective materials, bad tooling, poor operators, labor difficulties, consideration of any falling off in output in any department.

Meeting at 9 A.M. every day.

(3) Superintendent of assembling, chairman, with 4 foremen of most important departments.

Program similar to that shown under No. 2.

Meeting at 9 A.M. every day.

(4) Superintendent of inspection, chairman, with 3 or 4 of main foremen.

Typical program.

(*a*) Consideration of complaints from assembling regarding parts that have been passed that are not up to gauge.

(*b*) Scrap—when it is excessive and why.

(*c*) Difficulties arising in any department.

Meeting twice a week at 9 A.M.

In each of these sub-committees it is important that others of the foremen be called in occasionally. This makes them feel that they are not being neglected and that they have a chance to advance up the line.

(5) Superintendent of factory system with head of cost, stores, stock tracing, efficiency records.

This is one of the sub-committees whose work is very important.

Typical program.

(*a*) What materials in stores are so dangerously low as to be on rush list, and their condition.

(*b*) What materials are on hand that are not being used.

(*c*) What materials appear to be overbought.

(*d*) What work in process of manufacture is in worst condition. What are the real causes for this and what must be done to help out the situation, and so eliminate all chances of delaying assembly.

(*e*) What work in process and in finished stores appears to be on hand in too great quantities and susceptible to reduction.

(*f*) What items in production are the highest in labor costs—these to be reported to the factory manager and superintendent for investigation and action. The effective idea here is to exert a continual pressure on the shop to REDUCE COSTS.

36. The meetings of this committee should take place twice or three times per week, at such a time as to permit of thorough discussion. They will usually last an hour. They can be held late in the afternoons after the work of stores and stock tracing is mainly over for the day.

37. In all of these sub-committee meetings the factory manager himself should appear at intervals. Under exceptional conditions only should he take part as it is best not to interfere with the superintendent who is chairman. It is always effective, however, for him to put up to this chairman some particular problem to be solved by the committee.

38. The foremen should call together their job bosses once each month to discuss with them the practical problems of their departments such as training of operators, why production is low on certain jobs, suggestions on tooling and on perishable tools, condition of machine tools, etc. This will encourage them greatly.

39. With this system you get the use of a large number of brains on your problems instead of one as under the old method. When five or six such brains attack a problem it will be conquered. Someone will think of a partial solution; another will add to it; suggestions come thick and fast, and suddenly the chairman sifting out the best ideas has the solution. Each man in the discussion *understands it also* and he can and will give his help toward *carrying the plan through.*

40. Every man of them is getting better educated every meeting. They hear other men discuss the problems—get their view points and the benefit of their experience.

41. They become interested in the new problems presented. Their minds are shaken out of the old ruts. They think in a

broader, better way, and when they undertake a job of increasing a certain production, cutting down a certain cost, improving a bit of tooling, that job is as good as whipped that moment.

42. The working out of their problems together, the finding out that the man beside them has as great troubles as they have, the holding to "constructive suggestions and not destructive criticism" will bring out their better and more efficient selves.

43. And, *decisions are made immediately.* The questions are not laid aside "to be considered later" and then to be forgotten—only to arise later in an aggravated form. Quick, position action is the order of the day with the committees in full action.

44. Notwithstanding all my experiences in developing organizations I am continually surprised at the rapid manner in which a lot of grouchy, inefficient, disgruntled superintendents and foremen can be turned into a bright, lively "get together" lot of men who will work to the limit for the company.

45. Many of the greatest business institutions in America to-day recognizing the degree of power and control and possibility of development that it provided by the use of Committees, have built up their entire organization structure upon such a model.

46. The Great National City Bank of New York City is a prominent example. This large business institution is organized upon such a basis that from top to bottom run a series of powerful committees that contain the men with the best brains in the bank—men, who through thus meeting one another gain a remarkably thorough knowledge of the entire business and who thus develop the highest possible degree of personal efficiency.

47. Great organizers now believe that they must have some organization plans that will bring out, upstanding in the light, their best men and will develop them to their highest efficiency. They now know that a sane comprehensive system of committees will accomplish these results as will nothing else.

48. Such methods will develop your best men, give you the benefit of the best brains; force quick and positive action; leave nothing to chance; get a real spirit of pull together team work that will drive any concern forward to success.

CHAPTER XIX

WAGE SYSTEMS

Day Work—Piece Work—Premium Plan—Bonus Plan—Graduated Bonus Plan—Group Bonus—How to Introduce—Effect on Operation

1. THE wage system hits the worker's pocketbook and, therefore, is fundamentally important. So much has been written upon the various systems that no complete description is necessary, but some comments will be made relating to each, explaining my views as a result of shop experience.

DAY WORK

2. The day work system by which the operators are paid by an hourly rate without regard to production is thoroughly inefficient and costly. Some superintendents claim that while it is costly, still it is conducive to accurate work. This is a fallacy. The men loaf so on their jobs, get so slow, that they do poor work. Snappy production with proper supervision always brings good work.

3. When workmen are operators under day work, they lack incentive. They take their time on every movement. If they lack materials or tools, they wait without protest. If their slowness is caused by the slowness of another worker, they wait. The general policy under day work is the "take your time policy." The output should be from 100% to 150% higher than it is.

DAY WORK WITH A MINIMUM HOURLY PRODUCTION

4. Day-work system of pay, when coupled up with a minimum hourly rate of production, will work out better, though if the rates of production are what they should be, the men will become dissatisfied and want some system where their pay is dependent upon their own effort.

Piece Work

5. The old piece-work system is being criticised freely to-day, but it has many points of merit and to-day is being generally used throughout the United States.

6. It is the most inexpensive system of pay that there is, both in its installation and its up-keep.

7. The one big fault underlying piece work is the evil of bad price setting. Investigations, countless in number, have shown that in ninety-five per cent of cases the output upon which the piece-work prices were set have been figured entirely too low—hence the prices on the average are invariably too high. This condition usually arises from two causes.

8. When piece work is first installed, the usual practice is to go over the records of output made under day work and then calculate that under piece work a certain increase can be secured. Usually this is figured at 20% to 25%, and the prices are made accordingly. Right here is the fundamental mistake from which flows endless trouble. Instead of indulging in any estimates or guess-work on such a vital matter, the management ought to disregard the day-work records which represent only inefficiency. Careful tests, as described in Chapter VII, page 180 to 200, ought to be made in order to start this work on a solid foundation. The tests will soon show that instead of allowing for a 25% increase over the outputs under day work, the proper figures would be from 100% to 150%.

9. When this bad start is made then all kind of troubles ensue. When prices are set on new jobs the foremen refer back to the old prices on similar jobs and "estimate" accordingly. The whole set of prices with only a few exceptions will be entirely too high. Then follows the old story of the workers cutting loose, increasing their output and earnings, and then the slashing and cutting of prices by the foreman. Then follows the *restriction of output* by the workers. They put the clamps on and woe betide the operator that exceeds the limit, for when he does so and the prices are cut then the whole group of workers are forced to work harder and make no more pay. Remember, too, that this condition exists in the "open shop" as well as in the "union shop." Restriction of output then becomes a regular shop condition.

10. Then follows the increase of antagonism of the worker against the employer. On any new job that comes along the shop policy is one of "beat the company." And the moment they detect

any efforts by the employer to get at the facts by making time studies or tests, then are they ready for battle. They fear that when the manufacturer really gets the facts concerning proper prices that then he will make radical reductions that will cut the force of workers and compel them to work very much harder for no more pay.

11. The greatest difficulty facing anyone desiring to install piece work, using as a basis the standard outputs determined by proper testing and analytical methods, is that such outputs are so large that the operators honestly believe they cannot reach these— the proper piece-work prices so low that they feel they cannot earn a fair day's pay. I know that my thousands of operators would never have accepted my high standards of output, coupled with low piece-work prices, which they afterwards reached under my graduated bonus system with a common-sense training added. The final outputs were 40% higher than my first-class superintendents and foremen thought were possible.

Guaranteed Day Rates With Piece Work

12. Some attempts have been made to overcome this situation by installing very low piece-work prices (determined proper by tests), and guaranteeing the workers that they will receive a certain minimum day rate in case they cannot earn a proper amount through the piece-work prices. The trouble with this is that the day rates have to be so large that the operator is liable to be satisfied with them and may not make the effort necessary to earn more under the piece-work rate.

13. It may safely be stated that piece-work prices in most American shops, calculated as described, are the cause of much inefficiency and low output. Also, that it is very difficult to install piece-work prices, based upon a proper basis, in a shop operating under day work.

14. While I believe in guaranteeing prices against reduction, even when earnings become large, I do not advocate the guaranteeing of prices set by defective methods as it would be a serious matter for any company to guarantee that very high piece-work prices set in such a manner, would not be reduced. It would fasten upon a company a high labor cost that might cripple them when fighting against a competitor not so handicapped.

15. The *real* problem is first to find out *what* the output and

prices *should* be—then to introduce them with a guarantee against reduction, in such a manner as to satisfy labor with their fairness.

The Premium System

16. In the Halsey premium plan of pay the standard for the job is based upon the shortest time in which the job has been done in the past. If he does the work in less than the standard time he then receives his hourly rate of pay for the time spent plus a premium, which is based upon a proportion of the value of the time saved, using his hourly rate as the basis of value. This proportion usually varies from 1/4 to 1/2 of the hourly rate.

Suppose a worker requires 10 hours to complete a job ordinarily and that this 10 hours is adopted as the standard. His hourly rate is 50c. per hour, making total labor cost $5. Suppose, working under the premium plan he cuts the time to 8 hours upon which his premium rate is 50%. He gets 50% of 2×50c. (the saving multiplied by hourly rate), or 50c. His total earnings are then 8 hours times 50c.=$4 plus premium of 50c.=$4.50. His hourly rate then becomes 56 1/4c. per hour, and the manufacturer's cost is reduced to $4.50.

17. In this way the question of improperly calculated output will be taken care of fairly well, for the employer will get a portion of excessive earnings when the workers cuts loose and gets his production.

18. But there is one point here that sometimes causes trouble. The worker feels that he should have *all* of the excess earnings. The employer, if he knows the truth about the weakness of the basis upon which the rates are set, will know that the employee is *not* entitled to all of these extra earnings because a large proportion of them come, not from increased skill or energy, but from a defective method of setting original rates that arise from too low a basis for calculated output.

19. Even in the premium system I believe in establishing all rates upon outputs that are determined by a proper method of tests.

The Bonus System of Pay

20. The bonus system of pay, originally brought out so admirably by Mr. H. L. Gantt, is coming forward as the most effective system of pay yet developed. Its method consists of using as a fundamental basis the day-work system of pay with an added bonus in case the operator does a job within a predetermined time

or reaches a predetermined hourly output. As will be explained later, this is the simplest and easiest method of transferring from the inefficient day-work system of pay to one that will make the workers' earnings depend upon their output and bring out the highest efficiency.

The Graduated Bonus System of Pay

21. I have developed a "graduated bonus system of pay" that has proven very effective in rapidly increasing outputs of large groups of operators. My plan is as follows:

1st. Determine the *shortest space of time in which a job of work can be completed.* When quantity production exists then, from this, calculate the *output per hour that should be expected off the job—whether machine tool, bench work or assembling*—calling this the "STANDARD HOURLY OUTPUT."

22. 2d. These standard times and standard outputs on machine tools are to be determined by the use of the standard tables for cutting speeds, feeds, depth of cuts, for the various machine tools, and simple slide rules translating these data into actual time that will be consumed when such figures are used.

23. The standard time and standard output—Chapter X on machine tool jobs on which the machining time is short and the handling is long, or bench and assembling jobs where handling of parts and tools are the big factors, are to be determined by the methods of analysis—observation and tests as shown in Chapter XI.

24. Due allowance is always to be made for fatigue of the workers, the possible output of the *average* skilled worker being kept in mind. Every effort is to be made to persuade the worker to become *more* skilled—every operator to *use* all their skill producing and earning as much as they can. The only way in which this can be done is to guarantee the rates of bonus and this *cannot* be done unless the outputs are determined properly.

25. UNDER NO CONDITIONS ARE RATES OF OUTPUT AND BONUS RATES BE SET ON ANY "ESTIMATING BY FOREMEN AND SUPERINTENDENTS" OR "USING OLD RECORDS OF OUTPUT" AS A BASIS.

26. 3d. By examining and comparing past outputs and those shown to be the proper standards, the standards will be found to be so far in excess of the old outputs that the immediate practical problem is *how* to introduce them with a minimum of labor difficulties.

27. I will take a few concrete cases:

If the previous output on a job has been 12 per hour per operator—if the tests and analyses show that the standards should be 35 per hour per operator—how shall the operator be brought up to this point?

28. If the present production is 19 per hour and the standards are found to be 42 per hour, will the worker believe that he or she *can* do this much work?

29. The underlying principle of the bonus system of pay is that the workers shall be paid their usual day-work rate of pay, and to this will be added a bonus when their production reaches the standards. The method of calculating the bonus varies, but the principle is the same.

30. The operators, however, view this with suspicion. They fear that they cannot reach such high marks of production as are set and, therefore, they sometimes think that this is a scheme of the management to get them to increase their output per hour for the same hourly pay in order to persuade them to try to reach a standard that is impossible for them to attain.

31. A skillful ambitious operator is selected and he is taught how to so handle the materials, the parts, the tools, as to reach this output and so earn the bonus. When the other operators see this being done and the large bonus earned by one man, they are supposed to then seek the same output themselves.

32. I found that progress was slow, and that during the time the few operators were being developed, the balance stood aloof figuring that such large increases would cut many of them out of their jobs and, therefore, starting a strong sentiment against the method which made it more difficult to introduce.

33. I therefore devised and developed my graduated system of bonus pay by which the operators' bonus would *begin* at a point *well below* the high standard. A method that would make the operators feel that they had a chance to increase their earnings if they reached an output figure that seemed to them to be reasonable. Inasmuch as the gain in output came largely from their being shown *how to use the proper methods* and not from any greatly increased physical exertion, they soon get a taste of the extra bonuses. After once seeing that increase in their pay envelope their interest was aroused. They joined in the attempt to learn rapidly and soon passed from a low output to one higher and higher.

34. In the one case where the test showed a possible increase from 12 to 35 parts per hour, the bonus began when the operator

reached 21. In the second case, the operators who were producing 19 with a standard of 42 began their bonus earnings at 25 per hour.

35. The objection has been raised to this plan that the operator might be satisfied with one of the lower outputs and lower bonuses, and not strive to get to the highest point. I found that human nature—the desire to earn more—has the desired effect, and they all soon strive for the high earnings. Then, too, the company could and did prove that the standard hourly outputs, even though far in excess of previous results, could be reached without excessive effort. Our individual operator's records pointed out the laggards and the lazy so that they could be eliminated in case they would not make the effort to reach the standards. These records were far worth more than they cost us in making it possible for us to locate the efficient and the inefficient operators.

36. The bonus paid for reaching one of the lower stages of production (i. e., below the standard) were calculated at a figure sufficiently lower than the standard bonus to partially take care of the extra loss in overhead due to "below standard" production.

37. The point at which the "below standard production" bonus began was approximately 65% of the high standard output. When the standard was 35 per hour the "below standard production" bonus began at 23 per hour. When the standard was 42 per hour, the bonus began at 27 per hour.

HOW TO ESTABLISH MY GRADUATED BONUS SYSTEM

Setting Earning Rates on Jobs

38. Classify all jobs according to the degree of skill required for their production. Then determine the total hourly rates of day work (plus bonus) that is a fair return to each in case the standard hourly rate of production is reached. Thus is determined what the ultimate earning of the *average worker* (day-work rate plus bonus) should be *when producing up to standards.*

The Day Rate

39. I am assuming that the day rate paid to the workers have already been determined and classified. The more difficult the job, the higher the day rate—the less difficult, the lower. What these standards should be will depend upon the labor conditions of the locality, the cost of living and the prevailing rates there.

The Bonus

40. Again, the bonus to be paid will depend upon like conditions. The day rate plus the bonus determines the ultimate average wage as referred to in paragraph 38. Ordinarily, the bonus to be paid will be from $33^1/_3\%$ to 50% of the day rate.

One Danger

41. There is, however, one important point to be watched in this giving of bonuses and establishing of high rates of pay that is often overlooked until the avalanche strikes the company. If the operators throughout the shop, both skilled and unskilled, begin to make "big money" you can then expect dissatisfaction amongst the workers in inspection, stores, stock tracing, costs, tool room, tool designing, etc. They will naturally demand increases which are out of proportion to the value of their services or transfers to these jobs where the most money is being made.

42. Such conditions give rise to so much dissatisfaction that the total hourly amount that should be earned (day rate plus bonus) on each class of work in the opinion of the management, must be settled only after a careful survey of the entire situation. To simply settle on a 30% or 50% or any other percentage of increase over day rate for the bonus without regard to the other shop rate conditions, will result in trouble and unexpected and added cost.

43. For such reasons it is impossible to give any general rule for covering the proper percentage over the day rate for the bonus, excepting to say that it ought to be as *large as possible,* keeping in view the point brought out in paragraph 41. Probably a minimum would be 30% and a maximum 60%.

44. Here again the maximum will depend upon the existing rates of pay. Some authorities advise higher percentage of bonuses —going as high as 100%. This, however, depends upon the present day rate. A low day rate and a high bonus will always produce the best results, but again, factory conditions may have caused so high a day rate to be already paid that a 100% bonus may lead to too high compensation and costs.

Graduated Bonus System Provides for Increase Pay for Increased Production

45. It must not be forgotten that my graduated bonus system

provides for additional pay as the operators increase their production *above the standard hourly output.* This plan provided an added stimulus to the especially proficient workers. I have found that this tended to develop very high skill amongst the quickest operators. Under this plan the output reached by a few of the operators was really remarkable. It is, therefore, possible to set bonuses at a lower percentage such as 30% on a high day rate and still get good results.

46. My graduated bonus system of pay works out as follows: (The day rates used are only illustrative.)

47. FIRST STEP. Production work divided into three classes:

Class A (skilled) day rate	50c.
Class B (semi-skilled) day rate	35c.
Class C (unskilled) day rate	30c.

48. SECOND STEP. After considering shop conditions on all jobs and existing conditions in the locality, it was determined that bonuses should be set that would enable the average skilled worker to earn as a total (day rate plus bonus) as follows:

Class A, day rate 50c., total allowable earning 70c.—
increase 40%.
Class B, day rate 35c., total allowable earning 52½c.—
increase 50%.
Class C, day rate 30c., total allowable earning 45c.—
increase 50%.

49. THIRD STEP. The bonuses on Class A jobs were determined as follows:

Job production of part *H*-8 on hand turret screw machines, first operation:

(*a*) Operator now producing	16 per hour
(*b*) Standard hourly output should be	40 per hour
(*c*) Operator's day work rate per hour	50c. per hour
(*d*) Total allowable earning (day rate and bonus) allowable	70c. per hour
(*e*) Actual bonus per hour	20c. per hour
(*f*) Bonus per part *after* output of 40 per hour is reached (or exceeded)	½c. net

Setting the Bonus for Production Below the Standards

50. A moment's consideration will show that from the standpoint of *proper costs* the operator is not entitled to a bonus for any production below the standard. In this case the operator *should* produce the standard of 40 per hour, on which production he will earn 70c., the parts costing in direct labor 1.75 cents each.

51. Assume that the overhead cost is 100% on direct labor, and that the overhead per hour properly chargeable against the machine tool would be 70c. If the production is lessened this overhead would be lessened only by diminished costs of a few items such as inspection, oil, power, etc., which will not be large factors unless the reduction is very material. Therefore, the overhead chargeable per part would be 1.75 cents each on a production of 40 parts per hour.

52. The moment the production dropped below 40 per hour then the overhead per part would increase. On the other hand, however, when the operator is producing only 16 per hour the costs, both direct and indirect, are very high and, therefore, any inducement that will ultimately lead to a production of 40 per hour is well worth the cost.

Bonus on Production Below the Standards

53. I, therefore, begin my bonuses that are paid for production below the standard at 65% of the standard. Of course, if the *actual* production is up close to the *standards* determined by tests then this "below production bonus" will not be so important and may be disregarded or modified—but in the average case the standard production shown by tests to be possible will be so far above the actual that these "below standard bonus" may well be applied.

54. These bonuses which begin below the standard production may be figured at approximately 60% of the full bonus for parts produced between 65% and 80% and 75% for parts produced between over 80% and under 100%. All bonuses to be added to the day rate earnings. It will work out this way:

(*a*) Bonus per part after output of 40 per hour is reached (or exceeded) .... .5 cent
(*b*) Bonus per part for production between 33 and 39 parts per hour .... .375 cent

(*c*) **Bonus per** part for production between 26 and 32
parts per hour.................................. .3 cent

The Way the Plan Works

55. Thus, an operator producing 16 to 25 parts per hour while earning the day rate would be detected in their inefficiency by the methods already described. Every method of training would be applied to bring up their output for, of course, they could not be allowed to occupy valuable machines and floor space going at any such rate of production. When proper overhead is applied against an operator producing such low outputs the costs are very high.

When, by training and overseeing they reach 26 parts per hour, then they earn three-tenths (.3c.) of a cent each in addition to their day rate on all parts produced up to 32 per hour.

When their production gets above 32 per hour they then earn .375 cent each, in addition to their day rate, on all parts produced up to and including 39 per hour.

When the production is increased to 40 per hour or above, they then get a bonus of one-half (.5c.) cent for each part produced plus their regular day rate.

56. During each step from one classification to another the workers are watched carefully and they are given to understand that while the company is willing to pay them modified bonuses for lower than standard productions, still they are not supposed to stay in one of these lower classifications for any great length of time, but are expected (and assisted) to reach standard hourly output as described.

The Group Bonus System of Pay

57 I have often found it difficult to set bonuses on jobs such as assembling where there are a number of small operations, each performed by a separate operator or operators, all together going to make up one whole assembly or sub-assembly.

58. For instance, I had one assembling job which was a particularly difficult one upon which to establish standard hourly outputs and proper bonus rates. It was made up of four separate sub-assemblies. A careful analysis of these four sub-assemblies showed that they were composed of twenty-six (26) separate and distinct operations, each of which could well be performed by separate operators.

59. Each individual operation was small in itself and it was

apparent that, when the system of assembling was changed from the assembling of the four sub-groups to the progressive method, by which the work flowed from one operator to another, (see Chapter XIII) each one performing an additional operation upon it, there would be an undesirable cost involved in calculating and distributing the various bonuses and pay.

60. I therefore worked out a "GROUP SYSTEM OF BONUS PAY" that eliminated the necessity for keeping track of the output of the individual operators. The plan was worked out as follows:

61. FIRST STEP. Each of the 26 operations was considered by itself and a day rate fixed thereon in proportion to the care and skill required for the work. For instance: Job No. 1, "inspection of part," consisted of a visual examination to see that all threads were perfect (no gages used), and was a task requiring no skill; the day rate was 27½c. per hour. Operation No. 2, however, "milling slot '38,'" required great care and a higher degree of skill. This operator's day rate was 30c. per hour. The day rates for the various operations ranged from 25c. to 27½c. to 30c. to 35c. per hour, the last rate being paid to operators working upon jobs requiring the highest degree of skill.

THE BONUS

62. A bonus figuring 50% of the day rate was calculated as being correct for this job. The amount was to be paid as a group bonus as soon as the output reached a standard hourly output of 2600 parts per hour. When the output exceeded 2600 per hour, the bonus increased in proportion to the number of parts produced in excess. In this way the operators increased their earnings as they increased their output.

BONUSES AT LOWER PRODUCTION

63. The standard hourly output of 2600 was so greatly in excess of any records made previously that smaller bonuses were figured for outputs below the standard of 2600 on the same basis, as explained on pages 287 to 294, in order to spur the operators on in their efforts. No bonuses were paid for inspection, as their output was based upon quality and not quantity.

DIVISION OF THE BONUS

64. The total bonus was divided amongst the operators in the

proportion of the daily time spent on the job by each one multiplied by their day rate. Thus the operators on those jobs requiring the higher degree of skill quite properly received the highest pay. We had "floating experts" who could take the place temporarily of any operator who might be absent.

Training

65. When the work was first started we had selected skilled operators whose job it was to act as teachers or trainers of these groups. The moment any of the operators began to fall behind in their work just that moment the work began to pile up in front of them—and also just that moment the other operators began to clamor because the standard output was falling down and THEIR BONUSES WERE BEING REDUCED. The teacher would step in and aid the slow operator, concentrating upon him or her until their skill was developed or they proved hopeless. The new operators always received special attention.

66. By putting fast operators at the beginning—at various points between the beginning and the end, and at the end of the sequence of operations—and then concentrating the training upon the intermediate operators who were falling behind, the production was soon speeded up. Each operator, working upon one job only, eventually acquired a surprisingly high degree of skill which made it possible for them to increase the output above the standards and earn more money.

67. An entire assembling department of over 2200 operators were rapidly placed on this basis with most excellent results. Many a job at first glance appeared too difficult to place upon such a basis, but we found that this method of analysis—separation into elements, getting standard hourly output on each element, training by intensified methods—and offering generous bonuses to reach the standards could be applied to all of them and invariably resulted in very large output increases.

68. This same plan of group bonus can sometimes be applied to a number of operators working on the same class of work. When it is done the operators naturally watch one another and urge each other to the biggest possible effort. In fact, after the putting in of a group bonus plan, the questions of "everybody working" and "discipline" solve themselves.

Bonuses to Job Bosses and Job Setters

69. It always pays to give bonuses to the job bosses or job

setters who are *directly* over the operators. Their control, their interest, their influence are the *most vital* in the shop. The job boss's interest must be aroused by giving bonuses to him *which depend for their size upon the output of the operators under his control.* The plan must be such as to force him to spend most of his time and attention upon the *new* or the *poorer operator* so that he may train them speedily to get up to the standard hourly output. He cannot discharge them. Therefore, he *has* to train them—AND HE DOES.

70. He will be paid a bonus in addition to his day rate, which day rate is, of course, considerably higher than that paid his operators. His additional bonus may be equal to the AVERAGE BONUS EARNED BY HIS OPERATORS or his bonus may be graded ACCORDING TO THE AVERAGE OUTPUT OF HIS OPERATORS. The idea, in any case, is to penalize him automatically for any fall down by his operators so that it will be *to his interest* to get the *output of all of them* up to and above the standard hourly outputs. This plan invariably works.

Bonuses to Foremen

71. Bonuses to foremen which depend upon the quality and quantity of output from their departments also pays big returns. It must increase as the output increases and decrease when the output falls down. This method is very effective in bringing to light any difficulties that may be holding back a foreman's output, especially if it is "the other fellow's fault." Ordinarily, if another man's department is at fault and lowering his output, he will not complain for the chances are that it will not be discovered. But let such a delinquency "hit him in his pocketbook" and he will soon be after the tardy one.

Group Bonuses to Foremen

72. I have applied the group bonus idea to the foremen with good results. I have classed all the foremen producing one product into one group. I have then set a standard daily production *schedule for all parts* for this group that will be sufficient to maintain the regular finished output.

73. Then I have offered a graduated group bonus (payable weekly) to this group which depends upon the *completion each day of a full complement of all parts.* If there are 60 parts to a product and the daily consumption is 2500, then this bonus is paid

to the group *only* if 2500 pieces of *each of the full 60 parts* are produced each day. If they produce 2600 pieces each of 59 parts *and only 2000 of the one part, they then* GET NO BONUS.

THE EFFECT

74. The moment this procedure is adopted then each foreman becomes intensely interested in first getting their own output and next in helping the other foreman to get out his also. After starting this plan we were interested to find our foremen holding early morning meetings before the shop started in order to "line up their work properly and help each other out," as one explained to me.

HOW TO INTRODUCE NEW METHODS

75. When new and more progressive methods are to be installed into a shop, no better thing can be done to gain the interest and help of foremen and job bosses at the start than working up and offering a generous bonus system of pay for these men *if* they produce the results.

76. Show them that your big standard hourly output CAN BE REACHED. Show them that you can locate any of them who do *not* force their departments UP TO THE STANDARDS. Reward them if they *do reach the* standards, AND THE STANDARDS WILL BE REACHED.

CHAPTER XX

DETECTING AND TRAINING THE INEFFICIENT

Detecting the Inefficient—Rating of Workers—Training Operators in the Shop—Training Operators in a Special School—Bringing Operation Up to the Standard Hourly Output

Detecting the Inefficient

1. In all the work developed by modern methods, the most important is: the detecting of the inefficient, slow producers—the fellow who is getting out of your machine tool only 60% of what he should. The girl who, while getting a big day's pay, is assembling only 70% of what she could easily do. The locating of such inefficient ones so that they may either be *taught* how to work or *forced* up to the proper standard output or *discharged.* That is the big thing in modern management. It is the only way in which a working force can be brought up to a high state of efficiency.

2. Frankly, however, the average manufacturer seems to regard any method that points him to his inefficient workers as something belonging to the hated realm of red tapism. Yet, if there is anything in all of modern factory management that is useful and tremendously effective as an increaser of production and a reducer of costs it is this. The cost is negligible when the collecting of the output data is done at the same time the worker's earnings are calculated. I will show how this can be made into an effective producer of results.

3. In Chapter III, pages 82 and 104, I showed how the data for the individual efficiency cards can be gathered together.

1st. "The standard hourly output," or the hourly output that the company has a *right to expect* off the job.

2d. The hourly average output (and scrap) that the operator *has* gotten off the job.

3d. His rating as an operator based on his record and comparison.

4th. Any causes for complaints that the foreman may register against the operator for lapses that are not serious enough to warrant discharge.

6. This record is made up weekly by the same department that makes up the pay-roll and from the same workmen's time tickets and, therefore, the records are independent of any one man. They show outstanding efficiency records that are unbiased and true, and that are of the greatest assistance to the factory manager, superintendents and foremen. See Figure 64.

7. These records are kept by the systems department or the department handling the pay-roll. THEY *must be kept up to date,* for woe betide the system if they fall behind even a week. The

OPERATORS INDIVIDUAL EFFICIENCY CARD — NATIONAL MANUFACTURING CO. — Date ....

NAME OF OPERATOR .... CHECK NO ...... NATIONALITY ....

DEPARTMENT .... JOB .... WHEN HIRED ....

RECORD OF TRANSFERS AND PROMOTIONS ....

STANDARD HOURLY OUTPUT ON THIS JOB IS ....

OPERATORS	WEEK END	WEEK END	WEEK END	WEEK END	4 WEEK END	RATING	WEEK END	WEEK END	WEEK END	WEEK END	4 WEEK END	RATING
AVERAGE HOURLY OUTPUT												
AVERAGE HOURLY EARNINGS												
	WEEK END	WEEK END	WEEK END	WEEK END	4 WEEK END	RATING	WEEK END	WEEK END	WEEK END	WEEK END	4 WEEK END	RATING
AVERAGE HOURLY OUTPUT												
AVERAGE HOURLY EARNINGS												

COMPLAINTS ....

FIGURE 64.—Form for Record of Operator's Individual Efficiency, Refer to Paragraph 6

calculations are made by the clerks who, after extending the worker's earnings, then add up the hourly or daily earnings to determine the amount due the worker for payroll. These clerks likewise add up from these workmen's time tickets the total number of good parts produced on each separate job, the scrap, the hours worked for the entire week. They then figure out the average output of *good accepted parts per hour worked* and the *number of pieces of scrap per 100 parts accepted* for the past week.

RATINGS OF WORKERS

8. Any worker with an output that averages less than 60% of the standard is a poor worker unless he is new to the work. They are in the "N. G." class.

Any worker whose output averages between 60% and 75% is a poor worker probably capable of doing better, and is in the "P" class.

Any operator who averages 75% to 90% of the standard is good or in the "G" class.

Any worker averaging over 90% is a first-class worker and is in the "F" class.

Any worker averaging over 125% in the "AA" class.

9. These records, filed according to departments, play vital parts in detection of the inefficient worker for training or discharge, location of the efficient operator, positive control of proper discharges, promotions, lay offs, wage increases.

Location of Inefficient for Training or Discharge

10. Once every month the man in charge of the individual efficiency records—and he should be a first-class one—goes over each

DATE ....

MR. *H. BROWN* FACTORY MGR.
DEPARTMENT *#4-MILL & H.SCR.* FOREMAN *J. CARTER*
HEREWITH IS REPORT SHOWING RATINGS OF OPERATORS FOR
WEEK ENDING *SEPT. 27/19.*

THOSE IN "N.G." CLASS -NAME-	CHECK NO.	JOB	ACTUAL HOURLY OUTPUT	STANDARD HOURLY OUTPUT	JOB NO.
J. SMITH	4682	H. SCREW	20	45	26
S. GREEN	5781	" "	18	45	26
B. COTTER	4871	MILL	25	62	32
H. GASTON	3915	"	20	49	36
C. GALLIN	3960	"	18	42	30
THOSE IN "P" CLASS B. BAUMIN	3716	H. SCREW	25	45	26
C. DONNIS	3924	" "	19	40	22
H. GRENNING	4615	MILL	21	[illegible]	37
IN CLASS "G" WERE 22 OPERATORS					
" " "F" " 18 "					
" " "AA" " 4 "					
			Signed	*G. Helling* Factory	System

FIGURE 65.—Form for Classification of Operator's, Refer to Paragraph 11

and every one, comparing the actual output with the standards and marking down in the column whether the worker is in the "AA" or "F" or "G" or "P" or "N. G." class.

11. He lists up the numbers of operators in each department that are in each class. He reports to the factory manager and superintendent (sending duplicate copies to the superintendent) the number in each class that each department contains, being careful to give a *list of names* and check numbers of those operators in classes "P" (poor) and "N. G." (no good), giving the *average output* and *scrap record* in each case. See Figure 65.

12. The superintendent should make his action on this report

his principal business if the best results are to be gotten. He first examines the report for each department. Instantly he has the full picture of the underlying HUMAN EFFICIENCY of any one department. At once he knows the weak spots in the human organization. He can put his fingers not only upon the inefficient departments but upon the *individuals in each department* that are not up to the standard. No longer is he hampered by guess-work and mystery. He can and does go down to the foremen and the workers and let them know that *he* knows of their being below par and that exact records show it.

THE EFFECT IS ALWAYS SIMPLY ELECTRICAL

13. The shop *wakes up*. No longer can any foreman and worker "put anything over on the old man." He "has the goods." His finger points right at Foreman Jim Smith's department and at all the Bill Jones, Sally Smiths, in the "N. G." class. The whole thing now becomes "personal." In my desire to make it *personal* I always use the *name* of the operator as well as the check number and also the letters "N. G." and "P" as class symbols. When an operator is in the "N. G." or "P" class neither they nor their friends can mistake their grade. They feel the disgrace of it without any comments being made and make every effort to shake it off by trying to become more efficient.

14. No longer can they hide behind any friendship or favor from the "powers that be" and dally lazily with their work. The search-light of efficiency and publicity is turned on them with its full glare. The best of it is that while this may at first cause resentment with the inefficient it is a huge joke and a real source of satisfaction to the *efficient* workers. At last the lazy and inefficient are detected. At last they, the efficient, come into their own by the recognition of their class. They will never foolishly try to unjustly protect a worker in the "N. G." or "P" class. It's all too clear.

15. The superintendent takes these records in hand and goes down in the department to interview the foremen. The operators know well enough what these records in his hands mean, and watch proceedings closely. After going over these, both good and bad, the wise superintendent will take pains to congratulate the job boss, and perhaps a workman or two, who have made a particularly good record. As a matter of fact I have shown how very effective it is to distribute bonuses to these job bosses all of whose

operators reach the "F" class or better. A word of praise to the job boss or workers means a great deal. It not only signifies that his work is appreciated but, best of all, it shows every job boss and every worker that their efficiency is not hidden with the foremen, but that THE MANAGEMENT KNOWS that they are capable men.

16. Does any sensible man have to be told of the vitalizing, vigor-arousing effect of this method as compared with the old, where each worker and each job boss worked away down in the shop without recognition for good work done?

17. This same plan has been carried out in many shops, always with the same result. It gives the management a *real control* of *production.* It is often wise to start such work on a small scale. Select a few of the parts that are most difficult to get through the shop and get the operators' records on these first. Compare them with records of what the output should be and then go after them, and you will see results.

Training of Operators

18. The war forced upon us a lot of labor, both women and men, that we knew were unskilled. It was clear that we had to train them in order to get a proper amount of work out of them. So training schools were developed and to our surprise we found it possible to train unskilled labor to produce close work under proper supervision. The plan was a great money saver and money maker for those who carried it out.

19. Many manufacturers have the idea that the plan applies only when unskilled women are placed in the shop. The fact is, however, that the average American workman who calls himself an all-round mechanic is anything but that. A few months' experience on a few machine tools and he is an "all-round machine hand" to hear him tell it. As a matter of fact, he is inexperienced. When he first gets in the shop his usual hope is that he will escape the eye of the foreman long enough to learn his job at the expense of his co-workers. When the foreman catches him out he goes—the foreman cursing the employment department for sending him such "dubs." Then he gets more of a similar stripe and the process is gone through with again. And all the time those valuable machine tools are either idle or working far below capacity. The busy foreman can never get the time necessary to train these men and women and probably has not the aptitude for the work had he the time.

20. Now, with such conditions, it cannot be doubted that some system of training will be very beneficial. The worker coming from the employment department must be taken in hand immediately under the supervision of a trained mechanic, an expert developer.

21. FIRST STEP. *The first step* is to ascertain how much or how little the beginner knows about the machine tool he or she is to operate, as this will determine the amount of training needed, and the class of work they can be put on.

22. SECOND STEP. Then is taken up and explained the character of the work and its tolerances, the best methods of handling the parts, the standard methods of handling any jigs or fixtures used for the work, any special tooling, the standard cutting speeds, feeds and depth of cuts, the standard hourly outputs, and the wage that a skilled worker can make. The worker is actually taught all of these points.

23. THIRD STEP. After 3 days the expert developer can determine whether the worker will ever "make good" on the job selected or if he or she should be transferred to some other work. Very often a poor hand screw operator will make a good inspector, or a poor, thick-fingered assembler can handle a punch press well.

24. FOURTH STEP. Each operator should be shown that the standard hourly output on his job *can* be reached and must be watched, helped and trained so that at least he or she knows the proper methods and movements to use.

25. FIFTH STEP. When they are well grounded in the best methods of producing their work and can produce up to say 60% to 70% of the standard output, they can then be turned over to their immediate boss who is perhaps a small job boss. This boss is not permitted to discharge an operator. It is his business to take each one turned over to him by the trainer and develop them further and get them up to the standard hourly output. Personally, I am strongly in favor of paying the job boss on a bonus basis. I have devised the bonus to depend upon the *average* output of *all* of his operators, thus making it very much to his interest to speedily train up the unskilled operator. He wants his bonus; he cannot discharge the operator; he *has* to make good with what he has got—consequently, he trains them in a hurry, in order to get it.

THE ADVANTAGE OF THIS PLAN

26. A few moments' thought, an application of common horse sense to the problem will prove to even that hard-headed old

superintendent who has no use for new fangled fancy ideas, that this plan has big advantages over the old one of dumping the new man into the shop, giving him his job and his blueprints or tools and letting him dig out for himself. While he is "digging out" his machine tool is working far under capacity—he is causing much scrap—and taking a lot of the time of the workmen next to him who will always explain to him their way of doing the work.

27. Until a man has been through this and has seen the real transformation from "dubs" to "big producers" he can hardly believe that such things can be accomplished.

28. We must not forget that this plan of training not only develops the beginner, but also makes it possible to train up the old worker who may be falling below the standards of output. It also makes it possible to detect the incompetent worker for this trained mechanic will soon spot the worst of them in the departments, whether or not he is assisted by the individual efficiency cards.

29. Of course, in localities where highly skilled help can be easily secured this need not be developed to a high point, though even then it is beneficial to show even the skilled worker the standard methods of getting the output and *proving* to him that it can be done.

30. One of the big advantages of this plan is that often lower priced labor, not highly skilled, can be used on jobs that ordinarily require high-priced labor, thus effecting a large saving.

A Practical Method of Training in the Shop Without a Special Training Department

31. First Step. Select the man for this work with care. He must be one of your best mechanics in order that he may gain the respect of the foremen as well as make a good instructor. Above all, he must believe in and be enthusiastic over the work—eager to make a record. Make him a full foreman and let him be responsible to the superintendent alone. In a large shop there will be required a number of such men, especially during the early period of work when the beginners are being trained and the older employees made more efficient. I have found, however, that when *the labor turnover has been cut down, as it will be under the methods,* then his work becomes much easier and few men are needed. The training of new employees is easier as there are fewer of them—the principal work being the locating of the inefficient ones and the bringing them up to the standards of output.

32. SECOND STEP. The training expert will take over the new employee after he or she has been brought to the proper department—bringing them to the machine tool and finding out by asking questions, just how much or how little they know about this machine and its operation, exactly what previous jobs make up their experience, what tolerances they are accustomed to. From this he can judge of how much training they will need. He may decide that they are fitted for a better or a lower grade of work and, if there are the proper openings, may transfer them to the other jobs accordingly. He will, of course, make notes in his note book covering all of these points.

33. THIRD STEP. He will then take the part and its blueprint and explain carefully the character of the work, its close points. He will give the worker his instruction card which specifies such items as proper standard cutting speeds, feeds and depth of cuts—show him what tools are needed.

34. If the worker is to set up the job he will explain the standard method of set ups.

35. If the job requires the use of jigs or fixtures he will show the worker the best methods of handling them.

35. If the job is one where the handling time is a big factor, then full instructions on this point are given.

37. He will show him what the standard rate of production is and show him that it can be reached.

38. FOURTH STEP. He will then start the beginner on the work and, after seeing that he has the proper start, pass on to another operator. The attention he will pay to any operator will, of course, depend upon their inexperience and lack of skill. He will, of course, keep notes of their need of training.

39. FIFTH STEP. He will then return to these operators frequently. I am assuming, of course, that under present conditions it is not necessary to take altogether unskilled labor and train them, but that the beginners put into the shop have at least some degree of skill on the work for which they were selected by the employment department. Under his concentrated attention they will learn rapidly and in a few weeks will be able to turn out a good production with little scrap.

40. It must be kept in mind that modern production methods depend for results on the *saving of time*, and that the standard hourly output on machine tools are based on methods of handling parts, methods of handling jigs and fixtures, methods of using the greatest possible cutting speeds, feeds and depth of cuts that will

save the most time—that on assembling jobs this standard output is based upon the best and quickest methods of handling parts and using such small tools as may be necessary such as will "save the most time." It is evident to any sensible man that the average worker must be instructed in the best methods or he will not get the results.

To Factory Management. Date..........

Herewith is Report on Training for Week Ending.........................

OPERATORS EMPLOYED LESS THAN ONE WEEK

JOB	NAME	CHECK NO	NO. DAYS HERE	STAND. HOURLY OUTPUT	ACTUAL HOURLY OUTPUT	OBSERVATIONS
OPERATORS EMPLOYED OVER ONE WEEK						

FIGURE 66.—Form for Report on Training, Refer to Paragraph 41

41. SIXTH STEP. Records must be kept by the training expert and sent to the superintendent once each week, showing the progress of the new workers. I use a typewritten form similar to Figure 66.

42. List up new employees by putting first the ones that have been in the shop less than a week, next in rotation the others according to length of service. The superintendent can then compare the actual progress, as shown by the outputs with the standard outputs, and, by consulting with the training expert and the foreman, can determine who shall be dismissed or transferred. One of the most important effects of this method is that these new operators are *shown* that the determined upon standard hourly outputs *can* be reached. The example to the rest of the shop is very stimulating.

43. Seventh Step. The old operators who are not producing up to the standards are being located also. The training expert with the foreman investigates each condition. The operator is asked to explain why he cannot reach the standards. If it be on account of some physical weakness or defect, he is then transferred, if possible, to some job where this trouble will not prove a handicap. If he is all right physically, he then is asked to produce steadily for an hour, his motions being watched. His faults are carefully corrected and he is given another chance. The trainer will watch and help him all possible. If he proves to be an incorrigible loafer, then he is dismissed. But, nine times out of ten, his output will come up to the standard.

44. If there seems to be any ground for complaints by the worker that the standard hourly output is put too high, then an *immediate investigation* must be made. If the rate is all right, then stick to it. If it be too high, then lower it and raise the price. This eliminates one common cause for shop discontent.

Using the Foremen as Trainers

45. Of course, it would be simple and easy to select for each department some assistant foreman to whom would be delegated this work. However, it is difficult to find men who are fitted for it. Assistant foremen rarely have the aptitude for it. If a concern is fortunate enough to have a number of assistant foremen who are bright, ambitious, and can see the worth of such a job, their use will solve the problems.

Training of Unskilled Labor

46. During the war it became necessary to use unskilled labor on much important work. To a concern contemplating the use of women or unskilled men the description of the methods used in a large shop in Dayton, Ohio, will prove valuable. In this case, all of the labor came to us unskilled and, therefore, it was impossible to train them in the shop itself. The throwing into the factory of thousands of women and men who knew nothing of the functions of the machines they were to operate did cause endless confusion, and no regular output until a separate training department was started.

HOW WE TRAINED 5000 WOMEN

47. Previous to the United States entering the war, and after

they did so, the shortage of skilled labor was so severe that it was found necessary to use totally unskilled labor and train it up to do the work which only skilled labor was supposed to be able to do.

Owing to the shortage of men, the main sources of supply were from the women in the neighborhood and they were re-enforced from the ranks of the older men, clerks and office employees, all of whom were unskilled.

48. The bases used in developing this mass of unskilled labor to a high degree of efficiency were:

1st. An intensified method of training previous to their entering the factory, and

2d. Thorough system of supervision after they were in the shop.

49. The excellent results secured by the methods developed were proof that training of employees provided a most effective means of increasing production and reducing costs.

As stated previously, I have found that a similar method of training could be used with excellent results upon the average unskilled American mechanic.

50. When a large force of new employees have to be employed during a short period the intensified method of the separate training department is undoubtedly the best practice. Of course, after the shop has been well filled there is no need of keeping up an elaborate training school unless the shop suffers from a large labor turnover. It is to be expected, however, that the labor turnover will be reduced to such a minimum that the flow of new employees will be comparatively small and, therefore, the training can be reduced to a minimum.

51. For the purpose of this article, I am describing below the methods used in training a large number of unskilled employees in order that the manufacturer may see just what methods were used and how effective they were.

Experience in One Factory

52. As the best example is an actual one, I will cite the experience of a company at Dayton, Ohio, which illustrates this point.

53. This factory employed 8600 people on war work, of whom over 5000 were women. Practically all of the mechanical operations, assembling and inspection were performed by women, all of whom started as unskilled operators and were brought up to a high state of efficiency by this training.

54. The work this shop was doing was of a close, accurate character in aluminum, brass and various other materials; the article being the Russian combination time fuse. The manufacturing limits ran as low as 0.0005 inch in a metal particularly difficult to work.

55. The machinery includes every variety, such as hydraulic presses, punch presses, milling machines of all types, hand turret screw machines, automatic screw machines, thread millers, drill presses and special machinery designed and built by the company. The company faced a totally inadequate supply of skilled labor usually considered necessary for such work. Men of any kind were scarce and many of these belonged to trades not at all allied to the mechanical trade—brick-layers, structural steel workers, masons, all intelligent men accustomed to high wages, naturally unwilling to accept a laborer's work at laborer's pay, and yet unable to bridge the gap caused by their ignorance of mechanical methods. But this gap, if bridged, could lead to good jobs at excellent pay and would give the employed the benefit of their intelligence and manual skill.

56. The other available supply was the women, intelligent, healthy, quick and earnest, yet barred by lack of knowledge. We felt that there must be thousands among all the walks of life who would gladly do this work if only they could be imbued with enough confidence to try it and be trained to do it.

The Woman Beginner's Fear and Dread

57. Before the training department was started, I noticed, particularly that when new girls came into the shop they were very nervous—badly frightened—and that they would often break down and weep because of the actual fear that took hold of them when they first stood before a big machine tool, the like of which they had never seen before, the uses of which they could not conceive, and which looked like a veritable monster to them. The more earnest a girl was, the greater her terror and the net result was that the foreman, in his impatience, promptly and continuously fired the best class of employees that it was possible to get.

58. I found that those who did remain were slow to learn, took much of the time of other operatives, and learned bad methods. Also, their percentage of scrap was very heavy.

59. After considering the advantage of putting these new girls in a quiet, well organized training department where they could be

taught carefully and in a kindly manner and then turning them into the production department as semi-skilled operators, I started the school.

The Training Department

60. The training department was located in a room entirely separate from the factory, particular care being taken to see that it was well lighted. We placed therein all the different types of machines upon which we considered training necessary and, in addition thereto, placed the necessary benches and fixtures for the teaching of inspection and assembly. We naturally found that one of the most important points was the selection of a proper head for this school. We secured a man who was a gentleman and who could get along with the women, and made sure that he was an expert mechanic and operator. In this connection, I have always found that the tendency has been to select men who were not sufficiently experienced.

61. In all cases where the women were taught the different jobs, the *teachers were women.* Women teachers were selected, so that when the new girl employee came into the training department ready to begin this strange work, the very first thing that she saw were these women teachers operating machines. Invariably this new employee would make up her mind at once that if *these* women could do the work, so could *she.* Naturally these women teachers were selected with great care, keeping in mind not only their skill as operatives, but also their capacity as teachers.

Careful Selection Necessary

62. The employment department (which we consider as of primary importance) selected the employees with care, keeping in mind the work that they were supposed to do, it being evident that some women were well fitted to handle certain heavy-duty machines, while others could handle only the light machines. It should be noted here that the foremen are not permitted to employ people, nor are they even permitted to recommend employment. Every effort is made to keep relatives or friends out of any man's department, so that there can be no favoritism charged on the part of any employee after he once gets into the shop. The employment of both men and women is attended to by the employment department without any suggestions being permitted from anyone.

63. We standardized carefully the system of teaching. A teacher handles from three to five girls at one time, depending upon the nature of the work. She first explains the character of the metal in the part, and the kind and function of the tools that were being used, going over very carefully with each individual employee the work that each tool was supposed to do—she operating the machine in order to illustrate each point. The new girl employees are then permitted to start the work themselves and each time any error is made they are corrected in a kindly manner and encouraged in every way to do their best.

Only Specialized Skill Is Expected

64. It is particularly important to note again that these new operators are trained to become skilled *only upon one particular job.* We do not attempt to give them a general mechanical education, for, in the first place, this would take too long, and again, we find it unnecessary as the employee becomes skilled on the one particular operation that she is being taught in a very short period, and any general mechanical knowledge necessary comes to her through her work in the shop.

65. The work in the training department sometimes develops the fact that the selections for the different operations as made by the employment department is not always best, and when we discover this, we shift the employee from one operation to another until the one for which she is particularly suited is found—we do this in the training department so that we will not have to do it in the shop.

66. The operators are taught not only the use of the different tools, but also the use of all the necessary gages. They are paid 20 cents per hour while they are being taught, and a careful record of their progress and efficiency is kept. The length of time required for teaching operators varies both with the operator and the class of work, but on the average, it ranges from three to not over ten days.

67. In less than ten days' time we turn out from this training department girls who can operate hand turrets lathes on work requiring precision. (See Fig. 2.) Each machine tool in the training department naturally gives us a greater production than would have been the case had we adopted the old plan of training the girls in the shop with the same machinery. After this preliminary training these girls, when entering the shop, attack their machines with

vigor and confidence, and it does not require more than three weeks for them to reach a high average of production, and thus begin to earn bonuses, distributed under the graduated system of pay which has been described. It is, of course, *necessary to continue in the shop the training* received in the school, and the organization was built up in such a way as to insure this.

Duties of the Job Boss

68. We divided the operatives into comparatively small groups, placing over each group a carefully selected male job boss. We use great care in determining the number of operatives under each job boss, being careful not to put under his control more than he could efficiently supervise, the number ranging from seven on more difficult jobs to 30 on the less important ones. It is this job boss's duty to set up the machines, keep them in excellent running condition and see that the defective work is kept at a minimum. He is responsible for both the quality and quantity of work delivered from his particular group.

69. To insure that the women operatives are treated fairly, and carefully supervised by the job boss in order that their production may be brought up to as high a degree as possible, we first establish the rule that the job boss could not discharge his operatives, and then developed a bonus plan of pay for him whereby the amount of his pay depended upon the *average* bonus of *all* of his operatives. It thus becomes to his interest to help the newer and poorer operatives, rather than concentrate his attention upon the good ones. It is always not only interesting, but indeed amusing to see the earnest way in which the job boss will pay attention to and assist the new and comparatively poor worker under this plan, because *his* pay depends upon *her* efficiency.

70. We are careful to get men who will treat the girls properly and who are well trained in this work. We are careful to see that the job bosses do not drive their girls to a rate of production so high as to endanger their health or make them nervous. The company impresses its policy of treating its employees fairly upon the job bosses, foremen and superintendents at frequent meetings, at which time the aim of the concern is explained and insisted upon.

An Example of Results

71. As an example of what can be done by inexperienced women on difficult operations I give you the following: We produce our

base forgings of aluminum on hand turret screw machines. On this particular forging there are 56 gaging points, with allowable limits on different operations ranging from 0.0005 inch to 0.002 inch. In January, 1916, the average production of 31 women employees was eight pieces per hour. While the operatives were apparently busy at this rate of production, my experiments showed that there should be produced from those machines as a fair production an average of 35 pieces per hour. We put our old operatives into the training department, and within four weeks after the new and old operatives had been through this training department, the average production was raised to over 25 pieces per hour, and to-day the average is over 55 pieces per hour. The same results were obtained on all of our work, such as machining, inspection and assemblage.

72. It is particularly important and interesting to note that many of our most skilled operatives are men and women well along in life. We find that while the young worker has more vigor, the older one is usually more careful and steady, and more anxious to keep up a high average rate of production. Their continuous work on their jobs bring this average production up to that of the younger and more vigorous.

73. We have demonstrated that strong, healthy women can do work requiring great precision, after they are thoroughly trained, quite as well as skilled men mechanics. As stated before, they work on hand turret screw machines, hand millers, power millers, drill presses, thread millers, punch presses, routers and special machines of all types. They are remarkably efficient as inspectors. We have also taught them to be excellent tool makers.

Women as Assemblers

74. As an example of what women can do in assembling, I give the following data: We have a large assembly department, employing over 2000 girls. Two sets of prominent engineers who investigated the possibilities of production from this plant reported that the best output possible from this assembly division was 15,000 complete fuses per day in two shifts. By thoroughly training the girls we have been able to reach an average production of THIRTY-EIGHT THOUSAND PER DAY IN ONE SHIFT. (See Fig. 6.)

75. In addition to the fuse work, our company is building optical instruments of a character that requires the greatest precision, much of the work being held within limits of 0.0025 inch. This

work requires not only close manufacturing, but also most careful work in lens making and grinding.

76. Before beginning this work, the organization made a minute survey of each operation, no matter how small, involved in the production of these instruments. This included all the manufacturing, assembly and lens grinding work. This company was compelled to build its own lens grinding machinery, as none could be purchased in this country. When we finished this survey, we had before us a description of exactly what was required on each operation. There was necessarily much work that was entirely new to us, as well as to other American manufacturers, owing to the lack of experience in this work in the United States.

77. It is interesting to note that we were advised that it would be impossible for us to get any high-grade lens grinders in the United States and many dire prophecies were made as to our probable failure. However, we started the training school in the grinding of lenses, and have developed a high-grade body of lens grinders, both men and women.

Our General Principles

78. While this article deals only with the question of the training of operatives, it should be understood that this is only a portion of our plans for securing maximum efficiency, satisfying our employees and securing greater production. Our complete methods are comprehended in the few general principles, which are as follows:

1. Treating our employees fairly and equitably.
2. Giving them a chance for advancement, based upon merit.
3. Establishing a fair wage system.
4. Training them to become more efficient, and thus more helpful, both to themselves and the company.
5. Showing an interest in the individual worker, instead of considering them as a mass.

79. I have always considered that a fair and just method of selecting operatives for advances is one of the essential points in factory management. In this case the giving of employees a fair chance of advancement is controlled by keeping records showing the efficieny of the individuals and providing that, when an opportunity of advancement arises, selection shall be based upon past performance alone. We always select the operator with the best record. Each operator in the shop knows that his promotion is controlled and determined by fair and unbiased standards and that his interests are well protected.

80. The system of training should be thorough, and should be designed to have it continued when the operatives go into the shop, through the job bosses, and in some cases through special shop instructors. The system of organization and training should be such as to compel the subordinates and directing heads of department to give the closest attention to the new and comparatively inefficient employees, and train them to become better workers.

Our Company's Bonus System

81. There should be a fair and liberal system of pay which will reward the employee for reaching high rates of production. This should be based upon the ruling that the women should get the same pay as the men for the same amount of production. The system of pay should provide bonuses worked up in such a manner that the average operator can earn bonuses even when they produce less than the possible number of pieces per hour. Our graduated bonus system of pay is an original one with the writer, and has provided an excellent stimulus to the operatives without inducing them to overwork themselves.

82. Its main principle is a graduated bonus system of rewards. By this method the operative does not have to reach the highest rate of production before earning a bonus, but bonuses are graduated so that the operative will earn a fair bonus at the lower production points, of course earning more as they increase production. Care is exercised to see that these production rates are fair to the operative. By the graduated system the usual criticism of the bonus system is done away with as the operative does NOT have to reach the highest possible point of production as determined by time studies, before beginning to earn bonuses. ONCE the bonus rate is set, it is NEVER REDUCED. If employees complain that the bonus is too low, a careful investigation is immediately made, and, if their contention proves correct, the rate is raised at once. If, however, the rate proves to be a proper one, we take pains to prove to them that is what it should be.

83. There should be a degree of supervision that will prevent the operators from overworking or straining themselves, through attempting to work too hard, in order to earn higher bonuses.

84. As stated above, we have a simple system of checking up outputs of operatives and groups, so that we can detect inefficiency. When this inefficiency of any operative or group is observed, we do not attempt to drive them to meet the proper output, but go to

them in a kindly manner and endeavor to find out the difficulties. If they are falling behind due to lack of training we send them back to the training department. If it is due to inability to keep up with the work owing to lack of strength, we transfer them to some other job better suited to their strength and capacity, for we feel that any operatives, after being employed by us even for a few weeks, should not be let go if they show a proper degree of interest. Thus we keep our turnover of labor down to a minimum.

85. In addition to these methods, we have, of course, the hospital, with its nurses and doctors, restaurants, a company band, and rest periods of ten minutes each in the morning and afternoon, all of which are most excellent. (The restaurant is shown in Fig. 7.)

86. The organization of managers, superintendents, and foremen all strongly believe that the simple direct method of training operatives to do the particular job for which they are selected will result in producing quickly, working people, either men or women, who will prove remarkably efficient on the particular job for which they are selected. We know that if the training is linked up with a system of management that looks out for the workers' welfare, that provides a just and fair method of promotion so that the worker can, through honest effort, break away from his old job to advancement, that provides a fair wage system, there will result a working body filled with enthusiasm and willing to respond to any call for extra effort.

INDEX

Abandoned Stock, Reduction of, 338
Action of Milling Cutters, 222
— — Tool on Metal, 168, 222
Analysis of Elements, 250
Analyzing Job into Elements, 190, 250, 258, 279
— the Job, 270
Angle of Clearance, 223
— — Rake, 223
Approval of Time Tickets, 283
Arrangement of Benches, 273
— — Machine Tools, 285
Assembling Department Reports, 97
— Jobs, 270
—, Progressive Method, 291–295
— Special Contracts, 279
Authority of the Inspector, 281

Benches, Arrangement of, 273
Bin Cards, Raw and Finished Stores, 127, 324
Blanket Requisition, 108, 328
Bonus System, 398, 406
Bonuses for Job Bosses and Foremen, 406
Bringing Output up to Standard, 360
Buying, Overbuying, 299, 310
—, Underbuying, 299

Capital, Tying Up, 318
Card, Bin for Stores, 127, 324
—, Instruction, 214, 278
Classification of Parts, 161, 240
Clearance Angle, 223
Commercial Cutters, 222
Committees, 14, 316, 388
Contract, Special Assembling, 279
Controlling Discharges, 377
— Promotions, 382
Coolant, 181, 224, 240
Co-operation, 384
Cost Department Functions, 343
— Reduction, 343
— Survey, 58
Costs, 58, 343
—, Overhead, 352

Cuts, Finish, 217
—, Finishing, 217
—, Tables of Roughing, 216
Cutters, 222, 223
Cutting of Rates, 365
— Speed, Feed, Depth of Cut, Lathes, 196, 206
— —, —, — — — Milling Machines, 230, 238
— —, —, — — — Planers, 248

Daywork, 394
Design of Fixtures, 238
Determination of Methods Required for Stores, 321
— — Standards, 149, 156, 168, 222, 244, 256, 270
Determining Order Limit, 323
— Rush Limit, 323
— Standard Outputs, 249
Discharge, 365, 377
Distribution of Overhead, 352
Division of Job into Elements, 250

Economy of Inspection, 280
Efficient Organization, 384, 386
Efficiency Reports, Foreman,
— —, Job Boss,
— —, Operators,
Elements, Analysis of, 250
— of a Job, 190, 250, 258, 270
Employer's Viewpoint, 150
Employee's Viewpoint, 151
Equalizing Wage Rate, 374
Establishing Bonus System, 400
Examples of Progressive Assembling, 291

Facts, Getting of, 36, 66
Feeds, 230
Finished Stores Bin Card, 127, 324
Finishing Cuts, 217
— —, Tables of, 217
Five Principles of Production, 17
Fixture Design, 238
Fixtures, 238, 247, 267

Fixtures, Planer, 247
Follow Up, Purchasing, 314
Foreman, 44
— Efficiency Report,
Foreman's Bonus, 406
— Production Report, 94
— — Schedule, 96
— Survey, 36
Foremen, 30, 44, 96, 139, 362, 388, 400
Forging Shapes, 170
— — for Tools, 170
Form for Follow Up in Purchasing, 314
— — Standard Hourly Output, 264, 275
Forms for Speeds and Feeds, 253
Functions of Cost Department, 343
— — Stores Department, 319

Getting the Facts, 36, 66
Graduated Bonus System, 398
Grinding Shapes for Tools, 172
— Tools, 172
Group Bonus System, 404

Handling of Work Time, Planers, 244
— Time, 241, 244, 256, 260, 270
Heat Treatment, 171, 224
— — for Tools, 171
— — of Milling Cutters, 224
High Costs, Location of, 351
— Speed Steel for Tools, 170

Importance of the Foreman, 362
Inefficient Worker, Locating, 411
Inspection, 64, 280, 283
—, Economy of, 280
— of Raw Materials, 282
— Survey, 64
Inspector, Authority of, 281
Instruction Card, 214, 278
Inventory, Perpetual, 331

Jigs and Fixtures, 267
Job, Analysis of, 270
—, Assembling, 270
— Boss, 102
— — Bonuses, 406
— — Report, 102
— Elements, 190
— Under Machining Time, 168, 232, 244

Keeping Down Abandoned Stock, 332

Labor Turnover, 376
Lack of Training, 385
Lathes, 166
—, Cutting Speed, Feed, and Depth of Cut, 196, 206
Limit, Rush, 323
Limits of Stock, Rush, 130, 323
— — —, Work, 130
Locating High Costs, 351
Long Machining Time Jobs, 168, 232, 244
Lubrication of Tools, 181, 224, 240
Locating Parts in Shops, 132
— Shop Troubles, 134
— the Inefficient, 411

Machine Tool Arrangement, 285
Machinery, 144, 290
— and Output Surveys, 144
— — Tool Survey, 144, 290
Management, 166
— Survey, 66
Manager's Report, 101
Manufacture, Progressive, 205, 295
Market Survey, 307
Markets, 307
Material Survey, 303
Materials, 303
Method of Progressive Assembling, 291–295
Milling, 222
Milling Cutters, Action of, 222
— —, Angle of Rake, 223
— —, Arbors, 229
— —, Clearance Angle, 223
— —, Commercial, 222
— —, Feeds, 230
— —, Heat Treatment, 224
— —, Lubrication of, 224, 240
— —, Speeds, 230
— —, Test of, 225
— Machines, 222, 225, 241
— —, Cutting Speed and Feed and Depth of Cut, 230, 238

Operator's Report, 104
Operators, Training of, 415, 418
Order Limit, 323
— Record, 326
— Limit, Determination of, 323
Output, 144
— Instructions to Foremen, 133
— Records, 75, 84, 350
—, Standard, 249
Organization, 384
— Efficiency, 386
—, Problems of, 386
Overbuying, 299, 310

Overhead Costs, 352
— Distribution, 354

Parts Classification, 161, 240
—, Locating in Shop, 132
Perpetual Inventory, 331
Piece Work, 395
Plan of Testing, 159
Planer Fixtures, 247
—, Handling Work Time, 244
Planers, 244, 253
—, Cutting Speed and Feed and Depth of Cut, 248
Policies Requiring Settlement, 370
Premium System, 393
Principles of Production, 17
Problems of Efficient Organization, 386
Production, Principles of, 17
— Report Form, 84
— Reports, 75, 84, 94
— —, Assembly, 97
— —, Foremen, 94, 96
— —, Job Boss, 102
— —, Manager, 101
— —, Operator, 104
— —, Use of, 113
Production Schedule, Foremen, 96
— Schedules, 139, 287
— —, Development of, 287
— Survey, 36
Progressive Assembling, 291
— Manufacture, 205, 295
— Method of Assembling, 291–295
Promotion, 367, 382
Promotions Based on Merit, 367
—, Control of, 382
Purchasing, 55
— Department, 299
— — and the Management, 316
— — Survey, 55
— Follow Up, 314

Quickening a Slow Job, 267

Rake, Angle of, 223
Rate Cutting, 365
— of Wage Equalization, 374
Rating of Workers, 410
Raw Materials Inspection, 282
— Stores Bin Card, 127, 324
Record of Orders, 326
Records of Output, 75, 84, 350
Reducing Costs, 343
Reduction of Abandoned Stock, 338
Report, Foreman Efficiency,
—, Managers, 101
—, Operators, 104
Reports, Assembling Department, 97
—, Production, Foremen, 94
—, —, Job Boss, 102
—, —, Manager, 101
—, —, Operator, 104
Requisition, Blanket, 108, 338
— for Stores, 329
—, Stock, 329
Results of Progressive Assembling, 295
— — — Manufacturing, 287
Roughing Cuts, Tables of, 216
Routing Stock, 119
Rule, Poliakoff, for the Shop, 209
Running a Small Shop, 7
Rush Limit, Establishment of, 130, 323

Saving Handling Time, 260
Schedule of Production, Foremen, 96
Schedules, Production, 113, 139, 287
Scrap, Accounting for, 280, 283
Selection of Tester, 184
Set Up, 268
Shapes, Forging and Grinding, 170, 172
Shop Management, 166
— Reports on New Materials, 315
— Rule (Poliakoff), 209
—, the Small, 7
— Troubles, Locating, 134
Short Machining Jobs, 270, 279
— — Time Jobs, 256
Small Shop, 7
Special Tables, 216
— Training Department, 418
Spirit of Co-operation, 384
Standards, Assembling Jobs, 270
—, General, 149, 155
Standard Hourly Output and their Determination,
Standards, Long Machining Time Jobs, 156, 222, 224
—, Short Machining Time Jobs, 256
Stock Limits, Rush, 130, 323
— —, Work, 130
—, Reduction of Abandoned, 338
— Tracing, 48
— — and Routing, 119
— — Survey, 48
Stores, 54
— Bin Card, 127, 324
— Department, 318
— — Functions, 319
— Methods, 34
— Requisition, 329
— Survey, 51
Strength of Arbor, 229
Study of Jigs, Fixtures, etc., 267
— — Set Up, 268

Survey, Cost, 58
— Machinery, 144
— Management, 66
— Material, 303
— of Inspection, 64
— — Markets, 307
— — Stock Tracing, 48
— — Stores, 51
— Output, 144
—, Production, 36
—, Purchasing Department, 55
— Tool, 144, 290
System of Bonus Payment, 398, 406
— — Graduated Bonus, 398

Tester, The, 159, 184, 239
Testing, Plan of, 159
Tests, 157, 159
Tickets for Time Keeping, 80, 283, 347
Time, Handling, 241, 244, 256, 260, 270
— Saving, 256
— Studies, Lathe, 157, 159, 161, 184, 189, 190, 193, 217
— Ticket, 80, 283, 347
Tool Action on Metal, 168, 222
Tools, 290
— of High Speed, Steel 170
Tracing Stock, 48
Training Department, Special, 418
—, Lack of, 385
— Operators, 415, 418
— of Operators, 418
— the Inefficient, 409
Turnover of Labor, 376
Tying up Working Capital, 318

Underbuying, 299

Viewpoint of Employer, 151
— — the Workman, 361

Wage Payment, Daywork, 394
— —, Piece Work, 395
— —, Premium Plan, 393
— Rate Equalization, 374
— Systems, 394
Work Limits, 130
Workers, Rating of, 410
Working Capital, Tie up, 318
Workman's Attitude Toward Discharge, 365
— — Toward Rate Cutting, 365
— Time Ticket, 80, 347
Workman's Viewpoint, 361, 365, 367
— Time of Planer, 244